

PROCEEDINGS OF THE TARO CONFERENCE

COOPERATIVE EXTENSION SERVICE • UNIVERSITY OF HAWAII



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CAN WE REVIVE A TARO INDUSTRY IN HAWAII?

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The very title of my talk this morning indicates that Hawaii once did have a taro industry. This will undoubtedly be substantiated by talks which will be given later in the day. However, I would like to point out that insofar as statistics are concerned, Hawaii had over 1,000 acres in taro production in 1948, but by 1963 this acreage had been reduced to 480. Why this reduction in production has occurred, I cannot specifically answer, but perhaps I can point to a few of the reasons.

Prior to World War II, taro flour was produced and shipped to the Mainland. As late as 1952 Dr. Glaser, our principal speaker of the day, attested to the fact that "a number of doctors. . . on the mainland had used the taro flour prior to World War II, principally in allergy work, and still enthusiastically endorse it." Through the closing of the taro flour mill, the demand for taro production would automatically have been decreased, thus reducing the acreage requirements. An additional factor which would have had a definite effect on the taro production was the consistent rise in agricultural wages beginning immediately after World War II. Since taro has been produced in the older methods of extensive labor and little capital equipment, taro has become more costly to produce and thus the market price reflects these additional costs. This, however, does not mean that changes cannot be made and that taro cannot be produced at a more favorable market price through the introduction of modern methods and whatever assistance the State can provide in promoting this product.

One of the on-going objectives of the State is to promote diversified agriculture, not only to meet the consumption needs of our growing population but also to increase our potentials as an export-producing area. Since taro is one of the agricultural products not presently grown on the Mainland but capable of being produced in Hawaii, it appears to be a logical product to promote with full State support.

The areas in which the State may provide assistance include not only the work which is being done by the Agricultural Experiment

Station of the University of Hawaii to increase the actual crop production, but in addition, the making available of State lands and the financial assistance which may be given through the Product Promotion Program, the Farm Loan Program, and the small business loan program.

It is the desire of the State government to establish an environment conducive to the continued growth of the established industries and to provide assistance to new industries by removing obstacles to fair and open competition. The second objective is to assist in the development of new sources of income and employment in the State.

A taro industry would definitely fall in the category of both of these objectives. We stand ready to do whatever we can within our capabilities to assist in reviving the taro industry. Its potentials appear to be unlimited; provided, ingenuity and imagination can create new and presently unthought of products. The values of taro as a baby and health food have been substantiated, but more detailed research may disclose even further possibilities for this as a food product.

WHY A CONFERENCE ON TARO?

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Putting on a conference primarily involves pre-planning and plans for this conference were actually started before September when I took a world trip. We have two major events that make this conference pertinent. One is the completion of Dr. Jerome Glaser's study on the clinical application of taro. The other is the progress report on growing dryland taro by the University of Hawaii's branch experiment station at Wailua, Kauai.

Now, in commencing this conference you should understand some of the guidelines. There are two that are particularly important. First, we are beaming this meeting primarily at the dryland taro. This does not mean that we are excluding the wetland taro which is actually chemically the same. But we are concentrating our program primarily on the dryland taro because it is a plant that is more easily mechanized and for that reason I believe has the greater future.

Secondly, we are not at who at what I will call the Hawaiian Market; the poi market, the exotic food. Rather we are aiming at the clinical food market. Are the nutritious non-allergic properties of taro sufficient worth to create a national market for it? I'm sure all the poi eaters say the price is too high, but it is available and this Hawaiian market is being filled. We are thinking in terms of a market that would be on a much larger scale and would have nation-wide potentials.

On my trip around the world I came to the conclusion that agriculture is a tough way to make a living. There are special reasons why. All the undeveloped countries in the world are essentially agricultural countries. How can we, on a U.S. standard of living, expect to compete with countries that are willing to make any sacrifice in order to get dollar credits? The answer is that we should look to the areas where we have a specific advantage for a unique crop situation. Only if this restrictive criterion is met should Hawaii move.

We have had a number of conferences on different crops where we appear to have this advantage. About two years ago we had a conference on macadamia in which we reviewed this crop in terms of

what potential it might have. I would like, today, to use those same guidelines and review taro to see whether we have potential in going through it with the various speakers who are reporting.

In my speech on macadamia I referred to an article in Economic Botany magazine which brought out that there had been five major crops in the United States that have been developed since the war. These are guar, ramie, sesame, safflower and castor bean. Essentially they're either fiber or oil crops that have unique advantages. All of them have certain special factors in common that served to create this potential. Today we are going to review taro, using these same specific criteria.

There are three important points to make a successful crop.

First is market. We will be reviewing today whether there is a potential market for taro as a clinical food.

Second is land. Do we have land available? We will review that subject today also. Tomorrow some of us are going to go up to Kauai where the land has somewhat less rocks and is better suited for a tuber crop. We will actually look at the lands and see the plantings of taro.

Third is mechanization. Taro is grown in a manner similar to the sugar beet and to the Irish potato. Both of these crops are mechanized and we will review whether similar techniques can be used with taro.

There are a number of things of secondary importance that these five crops had in common. One of the unusual factors is that there is always an initial boost to start a crop off. In the title for this conference you may have noticed we said "again". Actually we would be starting a taro industry again because it was just after the war Hawaii Taro Products Company went out of business. It went out of business even though it had a successful product with a real market. As far as I can determine, it went out of business because of a lack of availability of product. In other words, the factory was unable to control the producers. Before then--even long before James Michener--taro was the staple food of the Hawaiians who brought it with 23 other plants from the South Pacific. There have always been poi factories in the islands that sell food to individuals who are interested. Therefore, in several counts taro passes this test of having had an initial boost prior to major expansion.

Another need is to have a research organization do essential work on the new crop. On our program today you will note that there are four members of the University of Hawaii reporting on their research work. Some of this reporting is on projects that took place a

long time ago.

Third is the need to have a responsible group organization behind the development of the new crop. You will notice today that we have government support. We also have people from the Mainland who would be responsible in the marketing phase. I, among others, represent a company which has land, which could conceivably be converted on a concerted mass basis if other things met the criteria.

The other phase is on insect control and plant diseases. The crop must be relatively free of these pest problems. In taro it will be reported later that there are some pests and there are some growing problems but none of them appear to be too serious.

Another question must be answered affirmatively: Does Hawaii have a peculiar advantage that does not exist elsewhere? Taro is essentially a tropical crop. True it could be grown on Samoa, or one of the other South Pacific islands, but those islands have such disadvantages as lack of availability. Dasheen is grown in the southern states and is somewhat similar to taro but not the same. Essentially taro is a crop that is unique in the Hawaiian islands. We would have the first opportunity to go ahead with it.

This is what we are going to be reviewing in our conference today. We cannot go into the details on all the items down to the what we will call "the gnat's eyebrow" but we can cover the essentials so you will be able to judge.

What do we expect to accomplish? As a veteran of many conferences I'll say this: We will not suddenly have a bunch of people madly planting taro or have announcement of another taro factory just like another Waikiki hotel. What we are doing today is to give you a thorough economic study of this crop including all specialized fields. The University Extension Service has agreed to put out a publication of the speeches given during this conference which should serve for you as an economic study report. With this we will have a package hopefully to be used at a later date.

Finally, you people here today will be able to judge whether this is a successful conference and whether in fact taro does have economic potential. I am glad to see so many of you here to help us make an appraisal.

AGRICULTURAL HISTORY OF TARO

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HISTORY

Taro is one of the oldest of cultivated crops. Chinese books make mention of it as early as 100 B.C. and it was grown in Egypt before the time of Pliny (23-79 A.D.) for he mentions it as one of the established food plants of the country. The earliest European navigators saw it cultivated in Japan and as far south as New Zealand.

Taro (*Colocasia esculenta* (L) Schottl.) was truly the "staff of life" of the old Hawaiians and it was an important source of carbohydrate in the more southerly Pacific Islands where it continues to be extensively used.

In Hawaii and other areas, it is natural that varieties best suited to the uses in the area would be selected out of any varieties available and thus have given rise to types peculiar to the area and not necessarily found in other locations.

Taro was used for many purposes besides the staple food, poi, in Hawaii. Varieties were selected as being particularly suited as offerings to the Gods and other varieties for the making of puddings. Some were used for medicinal purposes but just how they were used is not clear. The royal taros, producing a pinkish or purplish poi, were reserved exclusively for the use of royalty and high chiefs. The gray or white taros were the staple food of the commoner.

The varieties of Hawaiian taros which have been studied may be grouped into four general classes as to corm color--red, yellow, light gray or white, and dark gray. "The yellow varieties are of interest in that the pigment is carotenoid in nature. A calorimetric analysis showed approximately 13 ppm of carotene in dried taro. This compares with less than 1 ppm found in white and red varieties. Due to the close relationship between carotenoid pigments and vitamin A the potentialities of the yellow taros as a source of this vitamin are indicated."

CULTURE

The cultivation of the taro crops was developed into a fine art in old Hawaii with variations of management to fit the peculiar ecological environment of soil, rainfall and nutrition.

The crop was grown in paddies under submerged culture, whose size varied from as small as 20 square feet to areas of a third of an acre or more. Extensive and intricate irrigation systems were constructed to insure continued and adequate control of water flow through the paddies and permitted isolation for drying any single paddy or sections for fallowing. In areas of fairly uniform and high rainfall, the crop was grown "dry land" or non-submerged, and great care was taken to conserve moisture with mulches to carry the crop through dry periods. Here again, field management of selected varieties and time of planting provided a system permitting continuous harvest.

As would be expected, yields varied considerably as harvesting and planting were conducted on a continuous basis. The good grower could predict within fairly narrow limits the yield and time of harvest for each patch or paddy, and timed his plantings accordingly. The varieties used also provided a basic variant in cropping time as some varieties could be matured in an eight-month period while others required 18 or more months. The longer growing types produced the higher per-acre tonnages. It is reported that tonnages up to 65 T.P.A. were obtained on favored areas where fertility, sunlight, water and disease were not limiting factors.

The taro industry today produces tonnages of 10 to 25 T.P.A. on 500 acres and the average crop time is about 14 months according to the last crop census. This supplies the present local taro needs with some export to the mainland as a canned or bottled product.

The increased use of commercial fertilizers in taro production has been a mixed blessing as it has increased the continuous use of the paddies with a possible increase of imbalance of the nutritional elements and a more rapid build-up of pathogens of root and corm rots. Pythium sp. is the most severe of the root and corm rots, and a "hard rot," locally called "guava seed," is suspected to be a physiological microdeficiency possibly compounded by an imbalance in nutritional levels. Losses from both of these diseases vary from 1 or 2% to as much as 100% in rare cases.

A debilitating leaf spot disease of wet-land taro is caused by Phytophthora colocasiae, one of the downy mildews, closely allied to the late blight of potatoes. Recent tests have shown a close rela-

NUTRITIVE VALUE

The following table of retention values of thiamine, riboflavin and niacin in home cooked taro was taken from a station publication by Carey D. Miller, et al. entitled "Taro is a source of thiamine, riboflavin and niacin."

Taro corms cooked	Moisture	Thiamine			Riboflavin			Niacin		
		As assayed mg/100 gms	Dry wt. mg/100 gms	Retention %	As assayed mg/100 gms	Dry wt. mg/100 gms	Retention	As assayed mg/100 gms	Dry wt. mg/100 gms	Retention %
Piko keo	74.3	0.111	0.432	77	0.030	(0.117)		0.47	1.83	(112)
Bun Lung	59.6	0.100	0.248	59	0.025	0.062	98	0.58	1.44	91
Dasheen	74.9	0.073	0.291	89	0.015	0.060	97	0.60	2.39	96

The following table is from Pacific Subsistence Crops and was drawn from several food composition tables based upon 100 grams of edible material:

Water	- 72.5 gm	Iron	- 1 mgm
Proteins	- 1.9 gm	Vitamin A	- 30 I.U.
Fats	- 0.2 gm	Thiamine	- 0.04 mgm
Carbohydrates	- 24.0 gm	Riboflavin	- 0.03 mgm
Fibre	- 0.8 gm	Niacin	- 0.4 mgm
Ash	- 1.3 gm	Ascorbic Acid	- 10 mgm
Calcium	- 30 mgm	Calories	- 100
Phosphorus	- 80 mgm		

Another table from the same publication compares different carbohydrate sources and their weights in gms to provide 100 calories.

White flour	26	20	8	226	5.4
Polished rice	28	25	8	560	2.5
(Polished, washed and cooked rice)	28	5	-	390	2.5
Sweet potatoes	80	80	48	559	24.0
Breadfruit	70	96	59	720	14.7
Taro	70	149	25	424	16.0

tionship between leaf spot incidence, high humidity, low temperature and little or no air movement. Currently fungicidal agents are being evaluated which appear to show promise of effective control of the disease.

Losses from the disease vary greatly, depending upon the degree of damage to the leaf surfaces. When leaf surface and even the petioles are damaged, then crop loss is very high.

Another foliar disease, Phyllosticta calocasiophila leaf spot, occurs exclusively in the upland taro, occasionally becoming very serious. Mechanical wind damage provides entrance of the organism and the disease is considered quite significant in wet weather when the spores are splashed from one leaf to another and under such conditions may result in serious loss of yield.

It must be noted that there are discrepancies in the figures from the various tables for the same material. The tables were taken from different publications and the analyses presumably were done with materials grown under divergent conditions. Under these conditions, complete agreement could not be expected.

Poi has been used in Hawaii as an infant's first solid food, initially as an admixture in the bottle with milk and later as a cereal substitute. The starch grains being of small size and readily digested, provide a starch easily assimilated and without the occasional allergy difficulties found with some of the other starches. A substantial part of the fresh and canned or bottled poi is being used in infant feeding.

An estimate of the acreage at one time devoted to taro culture would probably be considerably in excess of 10,000 acres. Much of this acreage is now being utilized as house lots or pasture for the culture of other crops or forest land. There still remains several of the larger valleys with adequate water sources which could be returned to the culture of taro should the need arise.

The areas of high rainfall below 2,500-ft. elevation unsuited for sugar growing could also be converted to taro culture with the possibility of mechanization to a greater extent than possible in wet paddies under the present system. A possible modification of the paddy system could increase mechanization in this area also.

It is difficult to estimate the extent to which an increase in taro acreage could be expanded as the factors of land rental, labor and the other farm operations all enter the picture as well as the value of the crop to the processor. Conservatively, two to four thousand acres are now available. It is visualized that there are about 10,000 acres of valley bottoms suitable for taro culture plus

several thousand acres of high rainfall uplands suitable for "dryland" taro production.

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SUITABLE LANDS FOR DRYLAND TARO ON KAUAI

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As you have heard in the earlier discussions of the history of taro production, taro is one of the oldest of cultivated crops. The first taro brought to the Hawaiian Islands is believed to have arrived here in 450 A.D. In spite of this long history of taro cultivation in the 50th State, locally recorded information on taro growing, particularly dryland or upland taro, is relatively scarce. In fact, to my knowledge only one report has been published on dryland taro, that by Norman King of the University Extension Service in 1936. In this report King acknowledges the lack of scientific research into taro production and reports data obtained from the experiences of early Hawaiians. These remarks are not made with the intent to belittle the value of this source of knowledge. Rather they emphasize the need for "scientific" research, such as being conducted by Dr. Plucknett and his staff at the Kauai Agricultural Experiment Station, to establish guidelines for site selection and other aspects of dryland taro growing.

Turning to Hawaiian history then, what criteria have been provided for selecting suitable sites for dryland taro production? Hawaiians early recognized two types of cultivated taro: "dry" taro (kalo maloo) grown in rain-water localities without natural or artificial irrigation and "wet" taro. They found some taro varieties which appeared to be best adapted to the drier environment but also a number of strains which could be grown successfully in both wet and dry conditions. But equally important, they found that "dry" taro will die if the earth around the corm and roots dries out and that taro cannot be "dry farmed" in the full meaning of this concept as applied to wheat production on the Mainland.

For the best results, the soil for dryland taro production should be rich and well-aerated and contain a goodly supply of organic matter. The Hawaiians had no word for humus or organic matter but lepo ula represented a desirable site horticulturally for taro. Lepo ula has been defined as the red earth or clay soils located on the Kula slopes. Here then are three important criteria for delineating suitable lands for dryland taro: fertility, adequate

drainage and moisture retention capacity. In actual practice such lands seemed to have been found at Kona on the Island of Hawaii, often referred to as the home of dryland taro in the 50th State.

Actually, the range in soil quality in areas of successful dry-land production has been rather great: from "soil so hard it is practically impossible to soften" to conditions where "the richness of the soil and the plentiful moisture" have made possible close planting of cuttings.

Dry taro takes longer to mature than wet. It grows more slowly even where there is plenty of rain and the corms and whole plant grow much larger and hence take longer to complete their cycle. In some localities with poor soil and little rain, taro may take as long as 4 years to mature. Its slow maturity is also due to the fact that dry taro is grown in cooler places, at altitudes up to 3,000 feet. In general, dry taro may be left longer in the ground after maturing--one of its distinct advantages over wetland taro.

In summary then, suitable lands for dryland taro production must embrace the following characteristics:

- (1) an adequate but not overabundant supply of rainfall--adequate in both total amount and in pattern of distribution;
- (2) a soil with a rich supply of plant nutrients or organic matter. These can be replaced or restored through fertilization;
- (3) a well-aerated soil with the facility for proper drainage--to prevent the occurrence of root rot and other diseases;
- (4) be located at elevations generally below 3,000 feet;
- (5) have gentle slopes and be available in units of adequate size for mechanized operations. Factors of economic significance which will be referred to again if time permits.

Now to apply these criteria in identifying suitable dryland taro sites on Kauai. Unfortunately, we do not have guide posts available in both publications and remanent terraces and other visual signs as exist for wetland taro sites. But, we do have the generalized land classification work of the Land Study Bureau of the University of Hawaii and the work on vegetation zones by Ripperton and Hosaka. Integrated together, these reference works will help us define or delineate the areas we seek.

Just a few general background comments about these data.

The basic element of the generalized land classification work of the Bureau is the physical nature of the land itself. Here, all

available data relating to soils, climate, topography, irrigation and land-use experience have been integrated and interpreted to create four basic land classes. These land classes, listed from the greatest to the least in suitability for intensive agriculture, are designated as A, B, C and D. Generally stated, lands in Class A are best suited for intensive agriculture. Those in Class D are generally unsuited for intensive agriculture, but often are suited for grazing, forestry, watershed, recreational or urban use.

Two of these land classes, A and B, are particularly relevant to this analysis. The specific definitions of these classes are as follows:

Class A - Lands well suited for intensive agriculture. In general highly productive, easily managed lands. Favorable soils and adequate drainage. Slopes generally under eight per cent. Temperature and moisture from rainfall or irrigation are favorable for producing any one or more of the following intensive crops: sugar cane, pineapples, vegetables, fruits and coffee. Specialty crops may be adapted in favorable climatic zones. Some areas of lower quality land may be included.

Class B - Lands moderately suited for intensive agriculture. Rating reduced from Class A by one or more less favorable characteristics in rainfall, soils, slope, erosiveness, temperature and sunshine. Slopes generally under 16 per cent. Areas may contain scattered tracts of higher or lower quality lands.

Turning now to the work by Ripperton and Hosaka, the close relationship between soil, climate and vegetation in Hawaii has led to the delineation of climatic and vegetation zones. Without dwelling on the details of this classification and complete description, one of these zones, D_1 , is particularly relevant to this presentation. This zone represents average annual rainfall conditions of 60 or more inches and embraces elevations generally below 1,500 feet. Portions of another zone, C_1 , may also meet the established criteria. This zone represents average annual rainfall conditions of 40 to 60 inches and elevations below 2,500 feet. It is acknowledged that periods of inadequate moisture may prove to be limiting factor to the use of lands in the C_1 zone. The boundaries of both of these zones have been imposed on one of the Bureau's generalized land classification maps for Kauai.

We have now delineated out the land which seem to meet the criteria of rainfall, fertility, drainage, elevation, topography, etc., established earlier. These are the Class A and B land in the D_1 veg-

etation zone and also selected areas in zone C₁. In zone D₁ alone, there are 1,166 acres of Class A and 11,239 acres of Class B lands. These lands would seem to constitute the primary source of lands suitable for dryland taro production on Kauai.

The economic factors of availability (ownership) and existing higher use--major elements alluded to in the fifth criteria--still must be taken into account. Time does not permit a complete analysis of these factors here, but the Land Study Bureau has the necessary tools for making this adjustment.

TARO PRODUCTION AND ACREAGE TRENDS

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Reliable data on taro production in Hawaii date back to the Census of 1930. In that year, production of both upland and wetland taro totalled 24 million pounds. Today, production in the Islands is only 9 million pounds.

In terms of acreage planted to taro, a 1937 report by the Agricultural Extension Service of the University of Hawaii shows that 1,230 acres were planted to taro in that year. Of the total acreage was all in wetland taro. Today, in 1965, we have 470 acres planted to wetland taro, and only 5 acres planted to upland taro.

Since 1937 both production and acreage of taro have trended downward. This trend can be seen in the attached charts prepared by the Department of Agricultural Economics of the University of Hawaii for the period 1948 to 1964. For easier comparison in the post war period, a table showing production and acreage data for the years 1948 and 1964 by islands has been prepared.

The following is a summary of the comparisons by islands:

1. For the State of Hawaii, the average acreage planted to taro (both upland and wetland) has declined by more than 50 percent.
2. The most significant decline in acreage occurred on the island of Oahu with nearly 400 acres going out of production since 1948. At the present time, we have only a few acres planted to taro on the windward side of Oahu. The decline in acreage on the island of Oahu may be attributed, in a large part, to the pressure exerted on land for residential purposes.
3. The island of Kauai is down slightly, in terms of acreage, during this period, but in the early 1960's acreage planted to taro went as high as 220 acres. Some of the land now planted to taro on this island was formerly planted to rice and represents a shift in production from one commodity to another.
4. On the island of Hawaii, acreage has also declined by nearly 50 percent. The bulk of the taro on this island now

comes from the Waipio Valley near Honokaa.

5. Acreage on the island of Maui is up slightly, but has remained about steady during the 1948-64 period.
6. The island of Molokai, which has never been a major producer of taro, has only a few acres planted to taro at the present time.

The data on production reflect the decrease in acreage, except that the decline in acreage has been larger (at 53 percent) than the decline in production (at 35 percent) for the comparable periods. This disproportion in decline may be explained by the fact that the yield-per-acre of taro in the past 5 or 6 years has been higher than 10 to 15 years ago. Better varieties of taro, heavier and proper application of fertilizers, and ideal weather condition in the major producing areas are partly responsible for the increase in yield-per-acre.

The trend in taro production for the post-World War II period. may be summarized as follows: (1) Both acreage and production have gone down since the end of World War II, but production has been steady in the past 5 years at a level of about 9.5 million pounds, (2) Upland taro production is relatively insignificant with only 5 acres planted at the present time.

The data for the past several years show indications that the demand and supply of taro are apparently in balance. With our present rate of consumption, 9.5 million pounds of taro produced each year seems adequate to meet our needs. The question which naturally arises at this point is, "Why hasn't the consumption of poi gone up when the population of the Islands has risen quite significantly in the post-war period?"

In order to delve further into this decline in poi consumption, we contacted some producers, processors, retailers and other persons associated with the taro and poi industry. The following are some of the replies of the respondents:

1. Changing dietary habits of consumers in Hawaii is a major factor in the decrease in poi consumption.
2. Answer is obvious if each of us asked ourselves this question, "How many pounds of poi did we consume last week? last month? or even last year?"
3. Poi is not a very palatable product to most adults. Unless you have developed a taste for it during your early years, you're not likely to continue to consume poi. For instance, how can you expect a mother to serve poi to her children when she, herself, never developed a taste for poi?
4. Our local haole population now represents the largest ethnic

group in Hawaii; and haoles have never been known to consume poi like they do martinis.

5. There is no evidence that tourists like poi. We understand that poi served at commercial luaus now come in smaller containers than they used to.
6. Poi is considered to be a staple to some consumers and competes with rice, bread, and potatoes. At about 26 cents per pound, at the retail level, it is expensive when compared with bread at about 23 cents per pound, with potatoes at about 10 to 20 cents per pound, and with rice at about 12 to 15 cents per pound. An oft heard comment at the retail level is that, "Poi is now a luxury item. It is cheaper to eat rice!"

From our discussion thus far, we may conclude that the demand for poi, as it exists today, can be met with our present acreage, predominantly of wetland taro, and an average annual production of about 9 million pounds. We assume, also, that with a captive market restrictive to marketing within the islands and a small quantity that is exported to former island residents on the Mainland that the price will remain fairly high.

We are meeting today, however, to explore the further expansion of the Island taro industry in terms of an expanded use for poi. We understand, further, that a presentation will be made later today on the potentials for poi as a baby food and for dietary and therapeutic uses.

May I conclude by posing some questions which are basic to further expansion of the taro industry in the Islands. Assuming that a potential market does exist for the expanded use of poi...

1. Is land suited for upland taro production available in the Islands? If so, where?
2. What are the prospects for a reasonable tenure for this land?
3. Will financing for such a venture be available?
4. What are the costs involved in upland taro production? Can operations be mechanized to eliminate the high labor costs now involved with wetland taro culture?
5. Can a farmer be assured of a reasonable return for his investment and labor? What can a farmer expect in terms of a price for his product?
6. Finally, could it be that there are other more attractive alternatives than taro production for our farmers?

TARO: Acreage and Production Comparison by Islands, 1948 and 1964 1/

	<u>Acreage</u>	
	<u>1948</u>	<u>1964</u>
Oahu	460	60
Kauai	210	180
Hawaii	240	130
Maui	80	95
Molokai	<u>20</u>	<u>2</u>
Total	1,010	470 (minus 53 percent)

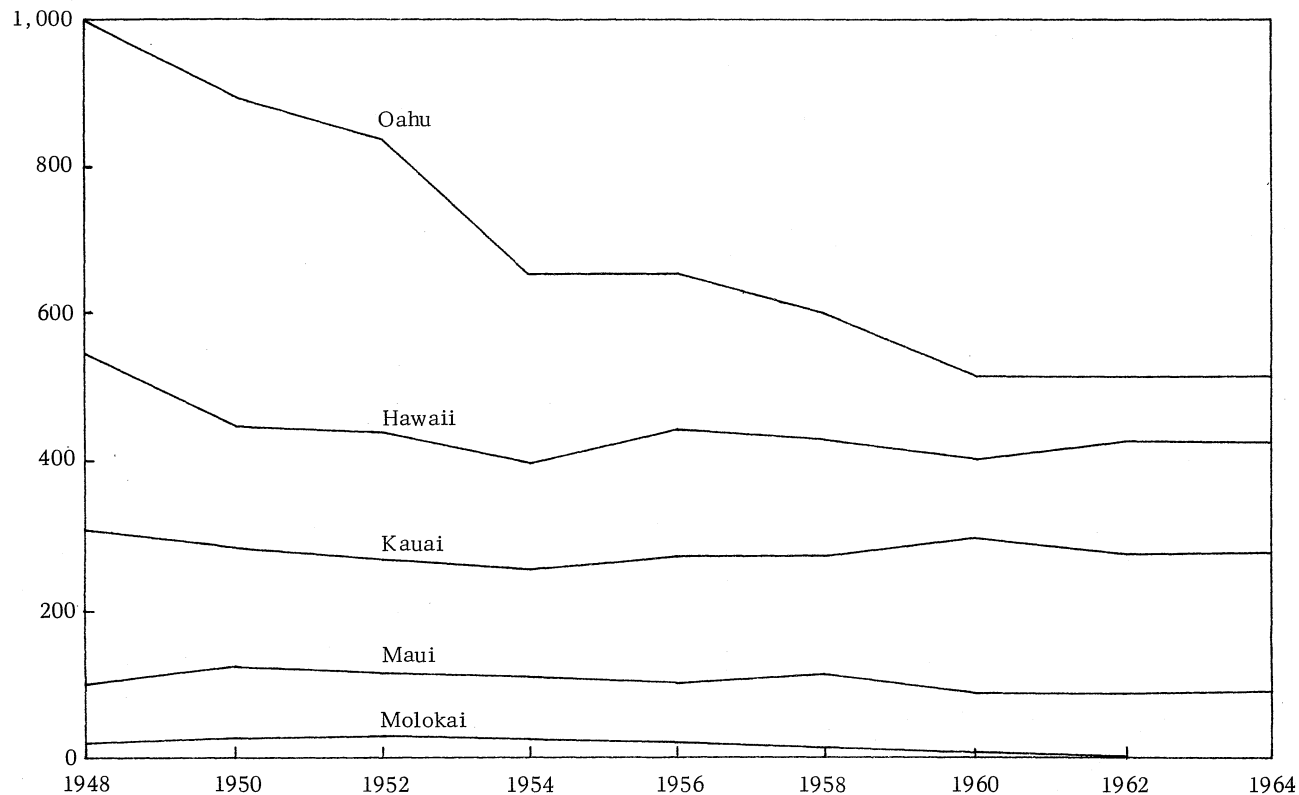
	<u>Production (million pounds)</u>	
	<u>1948</u>	<u>1964</u>
Oahu	6.4	1.1
Kauai	3.3	4.3
Hawaii	2.6	1.8
Maui	1.6	1.9
Molokai	<u>0.2</u>	<u>1/</u>
Total	14.1	9.2 (minus 35 percent)

1/ Includes both dryland and wetland taro.

Source of data: Agricultural Extension Service, University of Hawaii and Hawaii Crop and Livestock Reporting Service, Department of Agriculture, State of Hawaii.

Acres

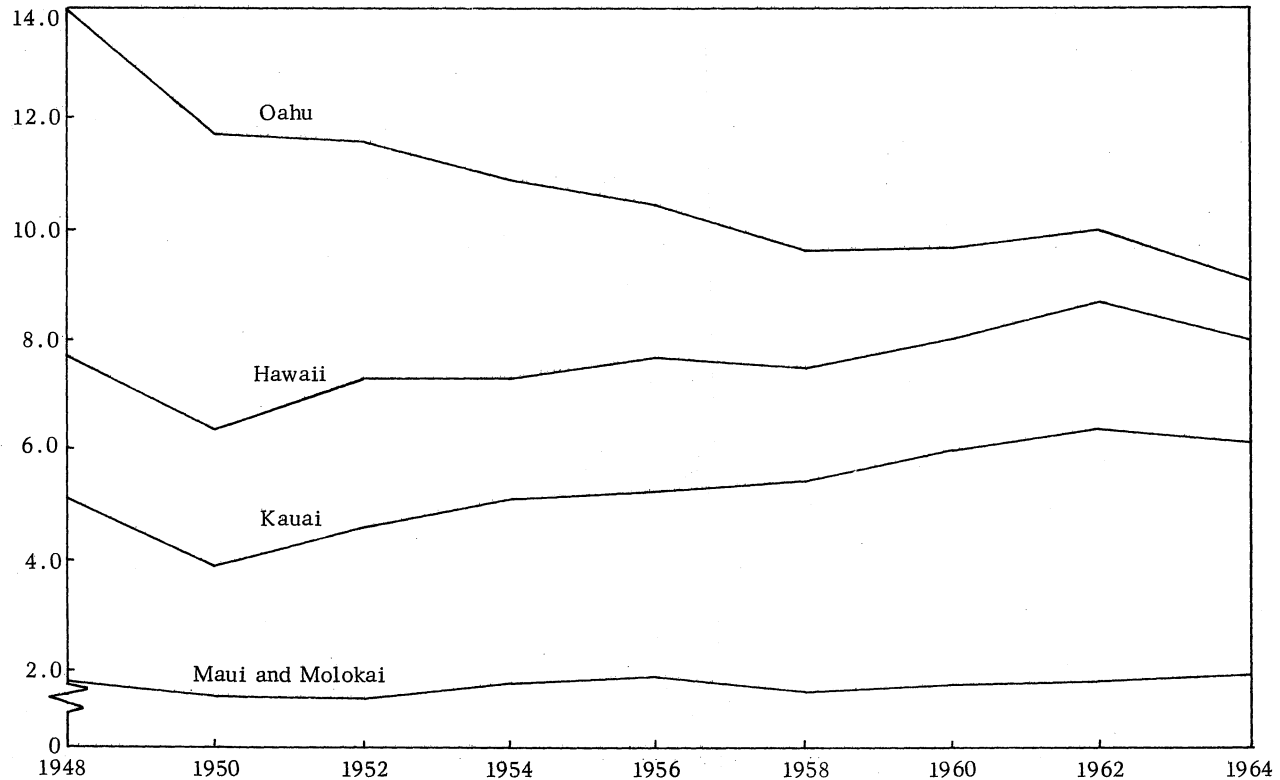
TARO: Average Acreage by Islands, 1948 - 64



Source: Agricultural Extension Service, University of Hawaii and Hawaii Crop and Livestock Reporting Service, Department of Agriculture, State of Hawaii.

TARO: Production By Islands, 1948 - 64

Million pounds



Source: Agricultural Extension Service, University of Hawaii and Hawaii Crop and Livestock Reporting Service, Department of Agriculture, State of Hawaii.

PRACTICAL ACCEPTANCE OF TARO AS A DIET FOOD

*Mrs. Marjorie Abel, Chief Nutritionist
Department of Health, State of Hawaii*

I don't remember when I first ate poi. I suspect that my mother used boiled or baked taro as a substitute for potato long before I was introduced to poi. I do remember staying at Mrs. Deverill's guest house in Hanalei, Kauai, when I was about 7, watching Mrs. Deverill pound poi and later make the paiai into small puff balls fried in deep fat. The memory makes my mouth water today.

To me taro and poi are no more bland and relatively tasteless than potatoes or rice. I suspect that much of the rejection by those who have not grown up with it is the color. I cannot think of any other food that is gray. Without precedent, gray does not suggest memories of other foods with pleasant associations.

Margaret Meade has probably done as much or more study as anyone on the development of food habits. She has said that we do not eat what we like, we like what we eat. When we are introducing any new food, it is well to remember this: We are not born with ready made likes and dislikes. We learn them all as our experiences with foods enlarge. Milk, whether from breast or bottle, is usually liked because it is associated with cessation of the pain of hunger and with the warmth and security of being held by the mother.

Later the reaction of adults and older children toward foods influences likes and dislikes. A baby is not physically ready to take food from the spoon. The tongue automatically pushes the food out instead of swallowing. An inexperienced mother will immediately decide that baby doesn't "like" the food and stop offering it. An experienced mother will put a small amount way back on the tongue so the baby has to swallow it. Then she will continue to offer the new food regularly in small amounts.

If the mother has an aversion to a food, her facial expression and her tension will convey this to the baby. Tone of voice will get across to the baby long before words are understood.

People do learn to like oysters, olives, and other prestige foods by repeatedly eating them to prove they are gourmets. The change may be slow as it was with my friend Janice. She was a conscientious soul and ate what was good for her. When she came to

Hawaii, she was told about the high food value of papaya. However, like many others, she did not like it at first. Day after day she ate a small piece and day after day she reported that she still didn't like papaya. But one day she came to the office with a beaming smile and the report that "I like papaya." When asked when this started, she said "this morning." Of course she was just illustrating Margaret Meade's law, "we like what we eat."

As far as increased use of taro and poi in Hawaii, the school lunches have proved that unfamiliar foods can be accepted. The nutritionists and public health nurses in the interest of economy and improved nutrition have succeeded in introducing non-fat milk solids and helping to make it a large item in the food picture.

The point is that if poi or taro is desirable the effort to introduce it to the individual should be persistent. Almost everyone can learn to like it. Napua Stevens, in a recent column, gave a hint--always use poi with some highly flavored food such as pork, jerked beef, salt salmon, or a well seasoned stew. Sweet poi can be used with sugar. If sweet poi is too bland, day old poi with its slight acidity may be better.

When we talk to people about using poi, common answers are: too expensive or too hard to get. One husky Hawaiian in Kona gave a different answer. He had beautiful teeth but his children had very poor ones. When asked if he had eaten poi, he agreed that his father had grown taro and made poi. As for himself, "I lazy, more easy go store buy rice." Cooking rice is not as much work as mixing poi.

As far as comparative costs are concerned:

- One serving (1 cup) of rice costs about 2 cents.
- One serving of potato costs less than 6 cents
- One serving of sweet potato costs about 7 cents
- One serving of taro costs about 5 cents

- Poi is a little harder to calculate. The poi with 30 percent solids sold in the market costs 26 to 32 cents per pound depending on the size of the bag. Mixed to 2-finger poi, this will cost from 8 to 10 cents.

For mainland use, those who have become accustomed to sour poi have found that the canned poi will not sour normally. Students have learned to add citric acid or vinegar to make it more palatable. Frozen poi in plastic bags is available in Wahington, D.C., according to a friend. This will sour if it is thawed in the top of a double boiler at about 120°F. This will restore the glutinous texture without killing

the organism that cause the sourness.

Medically, I have known patients with ulcers who can tolerate poi. One malihini nurse with ulcers found that it was the one food that satisfied her. She'd get up at night to eat poi.

For infant feeding, sales programs must be aimed at the mothers and their prejudices.

Other products that might gain mainland acceptance are taro chips, kulolo (made with taro and coconut milk), breads and biscuits made with taro flour. And while the necessary mechanization is being developed, I hope some thought will be given to saving and canning the leaves. Cooked sufficiently with a little fat or coconut milk to help eliminate the sting, they are a highly nutritious and delicious green vegetable which should not be allowed to go to waste.

RESEARCH ON POI (TARO)

Dr. Alexander Roth, Kaiser Medical Center
Dr. Joseph Oren, The Medical Group
Dr. William Moore, Straub Clinic
Dr. Ira Lichten, U. of H. Dept. of Nutrition

I. Objective

A study to determine value of poi (taro) as a non-allergic baby staple food (cereal type) for:

- A. Potentially allergic babies during infancy;
- B. All babies during the first year.

II. Background and Purpose

Historically poi has been a staple food for Hawaiians and it is presumed to have certain qualities that make it dietetically desirable. The purpose of these tests are:

- Test A. To determine conclusively whether poi (taro) fed as a cereal substitute to potentially allergic infants causes less sensitization than rice cereal fed to a second group of potentially allergic children.
- Test B. To determine whether poi is as desirable as cereals for babies, during their first year of life.

III. Method of Operation for Test "A"

- A. Only babies with a potentially allergic background will be chosen. This is defined as babies having one or more parents or siblings that have major allergies.
- B. Just after birth and prior to initial feeding, babies will be selected and placed alternately in one of two groups--one group to receive poi while the other group will have rice cereal. The mother will be given the information letter and asked to indicate willingness to cooperate in the study and to make personal medical records available.
- C. Prior to first feeding the mother will receive instructions from the pediatrician and be given either poi or rice cereal, Soyolac (if not being nursed by the mother), vitamins and minerals. At this time she will be given

- instructions in preparing poi for feeding.
- D. After first seeing the pediatrician the mother should report in at least once, preferable twice (monthly) during the first four months and again at the end of the fourth month. Her baby will not count in the experiment unless seen at least three times, that is, once about the end of the first month (or prior to leaving the hospital) when commencement of cereal feeding is to begin, a second time during the trial, and a third time at the end of the fourth month when the trial will be considered completed.
 - E. All children not showing allergic symptoms will be counted as part of the program regardless of whether the pre-scribed diet was complied with to the letter or not. For those showing symptoms the doctor should conduct a careful interview to confirm whether other allergy-causing foods were fed to the infant that might have caused these manifestations.
 - F. Feeding of prescribed cereal or poi is to start after the end of the first month and to continue through the fourth month, a period of between 2-1/2 and 3 months.
 - G. The following symptoms may indicate allergy and should be recorded: colic, gas, vomiting, diarrhea, constipation, excessive crying, nasal stuffiness, mucus in chest, wheezing (bronchospasm), and eczema. (It is presumed that doctors will diagnose symptoms differently but since each doctor will have approximately the same number under each of the two treatments any bias that might arise would be counter-balanced.)
 - H. Records are to be turned in to the University of Hawaii Public Health Department at the completion of the study period. Background information of the child is to include race. Record of performance is to include the date of visits and a report of the symptoms.
 - I. The Public Health Assistant is to follow up on patients and doctors and to audit reliability in reporting results.
 - J. Custody for funds, foods and drugs shall be handled through the College of Tropical Agriculture of the University of Hawaii.
 - K. This experiment will be conducted jointly by the Medical Group, the Straub Clinic, and the Kaiser Medical Center, plus assistance from the University of Hawaii Public Health Department and Department of Nutrition, State Department

of Planning and Economic Development, Chamber of Commerce of Honolulu, and C. Brewer and Company, Limited.

- L. Timetable: Test A -- The experiment is to begin on September 15, 1965, and new patients to be added till September 15, 1966. Results to be all submitted by December 31, 1966, and all results to be reported by July, 1967.

IV. Method of Operation for Test "B"

- A. Babies, preferably first born, are to be selected at random provided the mother is willing to comply with the purposes of the test. This selection will not occur until after the birth of the baby, while the mother is still in the hospital.
- B. During the first month, just prior to discharge from the hospital, patients are to be selected. Babies will be placed in one of two categories--those eating poi instead of cereal and those eating rice cereal. The mother will be given an information letter and asked to indicate willingness to cooperate in the study and to make personal medical records available.
- C. As she leaves the hospital the mother will receive instructions from the pediatrician and be given either poi or rice cereal, vitamins and minerals. At this time she will be given instructions in preparing poi for feeding.
- D. The mother should report in every month until the baby is six months old and once again at the end of the first year.
- E. The baby is to be fed either only poi or rice cereal as its cereal food. During the period of the test this should remain the only cereal fed to the baby. However as the baby grows, egg, milk, banana, and other foods may be added to the diet in the usual sequence prescribed by the pediatrician.
- F. The following should be made a part of the patient's record: All illnesses coming to the physician's attention, most particularly allergic symptoms; weight; length; and hemoglobin count of the baby taken at the sixth month and once again at the end of the year.
- G. Records are to be turned in to the University of Hawaii Public Health Department at the completion of the study period. Background information of the child is to include race, and whether the child's inheritance has a record of allergic tendencies.

- H. The Public Health Assistant is to follow up on patients and doctors and to audit reliability in reporting results.
- I. Custody for funds, foods and drugs shall be handled through the College of Tropical Agriculture of the University of Hawaii.
- J. This project will have the cooperation of the University of Hawaii Department of Nutrition and Public Health Department. Further assistance will be given by the Department of Planning and Economic Development, Chamber of Commerce of Honolulu and C. Brewer and Company, Limited plus review by various doctors conducting Test A.
- K. Timetable: Test B -- The experiment is to begin on September 15, 1965, and new patients are to be added until March 15, 1966. Patients will remain in the test until March 15, 1967, and the results are to be reported by July 1, 1967.

The contribution of foods and drugs made available by Honolulu Poi Company and Loma Linda Food Company, which made this experiment possible, are gratefully acknowledged.

ABSTRACT OF REPORT OF JANUARY 25, 1965.

Jerome Glaser, M.D.

Ruth A. Lawrence, M.D.

Anne Harrison, M.D.

M. Richard Ball, M.D.

Poi, prepared from taro, one of the oldest of cultivated crops, has been the staple carbohydrate food of Polynesia and particularly the Hawaiian Islands for centuries. Other parts of the world depend largely on the cereal grains, especially wheat, rye, corn, rice and others but none of these were grown in ancient pre-Captain Cook Hawaii, and for this reason, as well as other limitations of food supply, poi was the major food stuff. The Hawaiians were a tall, handsome race, characterized by splendid physique and good teeth. Much of this is attributed to the enormous amounts of poi they consumed. However, since the Islands were discovered by Captain Cook in 1778, with the introduction of the wide variety of foods used elsewhere such as the various cereal grains, beef, pork, milk, etc., the use of poi has gradually declined. Despite this, its value as food for infants, has long been recognized by Hawaiian physicians, including the very very capable pediatricians of Honolulu.

It has recently been felt, more on the mainland United States than anywhere else in the world, that allergic disease has been increasing both relatively and absolutely. Physicians are gradually awakening to the importance of the prophylaxis of these disorders which start largely in early infancy and childhood with manifestations of various types, particularly gastrointestinal disturbances, eczema (a very stubborn skin rash), frequent respiratory illnesses and asthma. When initiated by foods, which is very commonly the case in early infancy, the most important are the most commonly used, such as eggs, cereals (particularly wheat), and milk. Adequate substitutes for eggs and milk are readily available but not for cereals. Poi, because of its relatively low allergenicity, has proven to be ideal for this purpose. As interest in the prevention of allergic disease grows, poi should be used more and more for the starting carbohydrate food as a cereal substitute for infants born in allergic families who, because a tendency to develop allergic disease is inherited, are more likely to show such manifestations than those in non-allergic families. The importance of this problem is illustrated by the observation that about 20 per cent

of children on the mainland U.S. suffer from allergic disease. A recent publication from the U.S. Department of Health, Education and Welfare, which did not become available until after this report was written, indicates that allergic disease accounts for almost 33 per cent of all chronic disease reported in children under 17 years of age, and that one allergic disease alone, asthma, accounts for nearly one-fourth of the days lost from school because of chronic illness in this age group.

In the Department of Pediatrics, University of Rochester School of Medicine and Dentistry, Rochester, New York, it has been shown that poi is as adequate as the customary cereals for infant feeding. Moreover, it is very well tolerated even by premature infants. The experience of pediatricians in Honolulu with infants suffering from gastrointestinal disorders has been highly satisfactory. The taste of poi, which must be acquired by older children and adults, is not a factor in its acceptance by infants.

Poi also has a special property, unique in carbohydrates, in that it is an alkaline rather than an acid food and this doubtless accounts to a large degree for the excellent teeth of the ancient Hawaiians. It is also free from gluten as determined by chemical analysis, and its use in celiac disease, an illness of infants, caused at least in part by gluten in the ordinary cereals, deserves further investigation. It may also prove to be of help in a more common disorder of infants, cystic fibrosis, one of the symptoms of which may be severe gastrointestinal disturbances. This is now being studied. Poi has already proven invaluable as a cereal substitute in individuals allergic to cereals and will eventually find a place in the treatment of various gastrointestinal diseases in older children and adults as well as normal, potentially allergic and allergic infants.

The manufacture of poi should be standardized so that each batch will have the same composition as every other batch. Research directed at making the taste of poi more acceptable to older children and adults, already initiated by the Parke, Davis Company, should be continued. Because poi is low in iron, this should be added just as has been done with the customary infant cereals which are also lacking in this respect. Studies should be continued relative to the dehydration of poi for shipment overseas as this will greatly reduce its bulk and cost. Mixtures of poi with vegetables and fruits similar to the manner which is employed in the case of cereals should also be developed.

A REVIEW AND APPRAISAL OF TARO'S POTENTIAL

*James H. Shoemaker, Vice President-Director of
Business Research, Bank of Hawaii*

Since 8:45 some ten people spoke on quite a wide range of aspects of taro and I'm supposed to give this all to you in about 15 minutes.

Our able chairman who has kept this train right on schedule, that's Simon Legree Cooke, explained how it came about that I'm in this position. He said, "You don't know anything about taro so you can be absolutely objective," and I suppose I can be, but I do find myself in a rather difficult position in two respects:

One is that I'm not absolutely sure that I will pick out the particular things that you're interested in. You know last summer I was with my sister and brother-in-law in England and we were driving through Coventry. Someone said, "this is the place where Lady Godiva made her famous ride and they have a beautiful statue of her in the park and we're going to drive by it so you can see it." My brother-in-law said, "Good, I always wanted to see that horse." So you see, I'm not sure I'm going to pick out what it is you are really interested in.

The other is that all this matter of converting is a real problem and I'm going to follow the advice of an old pro who used to be president of Brown University when I was in the faculty. He said, "When I'm called on to summarize, I just put on the same old record and give it a helluva twist." And that is what I'll try to do. I see Simon Legree is looking at me here.

I'm going to divide what I'm going to say in two parts. The first part will be a very quick summation of what seems to me some of the notable things that were said or the points that were covered as we went along; and the second part will be an effort to summarize and bring out what seems to me to be, from the economist point of view, at least, the significant conclusions.

We got from Dr. Mark some rather interesting comments on the kinds of things which the State might do in the way of funds and investigating lands and providing general information, research grants, and coordinating efforts. This is quite a big program and one which is very important for the kind of things we are talking about.

From our chairman, the next speaker, we got I felt a very good perspective on this whole prospect for a taro industry in terms of what the principal problems might be. One of the things that I got out of what he said was that we were going to focus on this as a clinical food market. He also brought out some of the problems of competition in land and research and the necessity for responsible organizations to front the program. The problems of disease and pest control are some of the advantages that Hawaii has in this field.

I am covering this in such a way as to give us further perspective on what we are about to hear.

From Francis Bowers we got a lot of interesting spot review of what historically has happened in the taro industry. He brought out a few things to think about in terms of what they accomplished before as compared to what we are accomplishing now.

From there we went for a coffee break and then our chairman, in order to make sure that we were awake, made a quick little change on us and the man who was scheduled for 11 o'clock came in to talk to us; that was Stephen Doue who talked to us on acreage trends and I think most of you have the figures on that. I'll give you a couple of basics. In 1930, there were 24-million pounds produced and in '64, 9-million. In 1930, there were 1230 acres and only 80 of them were dryland. Last year there were only 470 wetland taro and 5 of dryland taro.

The next speaker, who was Dr. Plucknett, I thought gave us some very practical approaches to the problem in terms of the absolute necessity to deal with labor costs and his reasons for growing dryland instead of wetland taro. He got into the varieties and problems of getting the best materials for planting; of weed control; of fertilization. In this way he gave us a rich practical background.

The man who followed him was even more, what you might call, a hard-headed grower; Dr. Younge, who covered the point "Why Taro is a Dying Industry" in terms of market, the labor supply, the fact that work is extremely difficult, problems of weed control, and of course, his primary emphasis for getting away from, what he called, "Jackass Taro Production," by mechanizing.

We went on then to Harold Baker who reviewed suitable lands for dryland taro. He covered this in considerable detail. You need a map to get into this. The primary conclusion that could be drawn from this is that lands are available if taro production can be expanded.

We also got a very interesting history of some of the earlier efforts in taro technology from John Payne. He too gave us a good

deal to think about; the number of efforts they have gone into toward producing poi in factories.

Mrs. Abel spoke on taro as a food and I'm not going to go into details on that as the doctor who just spoke mentioned some of the same things that she did.

SUMMARY

Now if we're going to summarize from all these many angles that were reported upon, what would be the conclusions we might come to? Well, one is that taro has been a declining industry and the problem is, "What do you do to revive it?" There are many, many complex problems but there are too certain objectives. First is a reduction in cost through greater efficiency, and the second is a development of an adequate market. Basic in cost is labor and part of the difficulty, of course, is the character of the work; hence the absolute necessity to shift from wetland to dryland taro so we can introduce mechanization. I think it's quite impossible to get into many of the other technical aspects of this but it has to do with fertilization and irrigation, and other agricultural operations. On the one hand you have this problem of production and cost while on the other (and this was the basic purpose of the meeting) is the possibility of developing a clinical market. If I were to make some observations on this, the first would be that it is imperative to face the problem of costs and if you don't do that I don't think the rest of it can be even considered.

The second is if you're shooting for a clinical market, it is absolutely necessary to use either a rifle and not a shotgun because you're looking for specific areas in which to market your products.

Another aspect of that is that we tend, in Hawaii, to lose the significance of relative magnitudes. While we may say that the clinical market is a very small one, relative to the total market of the United States, the total market is so big that relative to Hawaii, even a small part of it would be a big factor here. In thinking about this we need to think in terms of outside developments that may impinge on our program of development. I mean, for example, processing and transportation--the rise in air freight is a possible factor. But the basic conclusion I would reach from this is that the worst thing to do now is to urge everyone to go right in and get started. I don't think that the industry is ready for this kind of action. I don't like to use the word "Research" because many people think of the word "research" as something that stops and keeps putting off action. What

I would say is, what we need is operational information for all facets of production and sales--in terms of what you can do about cost, in terms of the technique to reduce costs, in terms of techniques for processing and preserving, in terms of size and character of the market and what the market can absorb, and what the possible price levels at which you's have to sell, to sell competitively, and the whole areas of cost analysis from start to finish. We need, in other words, a kind of cooperation within the industry and cooperation between the industry and government to provide the basis for obtaining the kinds of information that are necessary to create a taro industry as a major crop for Hawaii. If we can do all these we can then, and only then, move ahead on a program of rapid expansion.

CRASH FOLLOW-UP FROM TARO CONFERENCE

The recent taro conference brought out that Hawaii may have here a crop of great promise. This would be particularly true if the contention of Dr. Jerome Glaser, Professor of Pediatrics at the University of Rochester (that poi is a major hypo-allergic cereal substitute available for a baby food), is confirmed.

Crash Research Program

However, the conference brought out that there are certain things that still need to be done before Hawaii can expand this agricultural crop.

1. Request the State Government to establish a grant-in-aid preferably with pediatric allergists in Hawaii that should confirm Dr. Glaser's contentions on the value of taro as a clinical food. (In addition it was recommended by Dr. Glaser that a local doctor be given a grant-in-aid to study use of taro in the treatment of gastro-intestinal disorders.)
2. Request the Hawaii Agricultural Experiment Station to operate a demonstration dry land farm using mechanized operations not only to prove the practicality of these mechanical methods but also so that costs of operation can be accurately estimated. A duplicate dry land taro farm should be operated in lands where wet land paddy-grown taro has been raised to ascertain difficulties encountered in the change of methods.
3. Taro is another small scale crop that would benefit from having the State establish a pesticide residue laboratory in Hawaii to expedite getting clearance on herbicides and fungicides that are of paramount importance in modern agricultural methods.
4. One of the difficulties in promoting taro is the problem of flavor and the prejudice people have against this product due to the way it tastes. The Food Science and Technology laboratory of University of Hawaii should start a project to develop means of enhancing the acceptability of taro. (Eventually it may be

- practical to develop a dehydrated product in the form of a flour but for the present boiled poi used as a cereal is satisfactory.)
5. If the work on taro as a prophylactic food for babies is confirmed and some of the other clinical uses of taro are also demonstrated, we need a program for launching this product. Logically, this should happen right here in Hawaii where the product is known and accepted. From the results of this, we should subsequently be able to market the product nationally using the cooperation of all local forces. If accepted nationally, there is reason to believe that taro's market will be international.

Obviously, this is not all the research that is required before taro can be expanded to a crop of importance to these islands. But these are the essentials that we have encountered thus far. From time to time it may be well to review the program.

Timetable

We should attempt to get this research program to a check point by July 1, 1967, and at that time we will plan to hold another conference apprising those interested of the situation. This date, two years from now, was selected to coincide with the earliest possible time when Dr. Glaser's work and the confirming date can be published in medical journals.

Dr. Clarence L. Hodge, Deputy Director
Department of Planning and Economic Development
Joe Kilcoyne, Past Director
Economic Development, County of Kauai
Dr. Kenneth Otagaki, Director
Department of Agriculture
Earle W. Sandison, Hawaii Representative
Mead Johnson and Company
Dr. James H. Shoemaker, Director
Business Research, Bank of Hawaii
Dr. Peairs Wilson, Director
Hawaii Agricultural Experiment Station
Richard A. Cooke, Jr., Chairman
Agricultural Committee, Honolulu Chamber of
Commerce and Director, Land Utilization
Program, C. Brewer and Company, Limited

POI--ITS USE AS A FOOD FOR NORMAL, ALLERGIC AND POTENTIALLY ALLERGIC INFANTS

Jerome Glaser, M.D.

Ruth A. Lawrence, M.D.

Anne Harrison, M.D.

M. Richard Ball, M.D.

From the Department of Pediatrics of the University of Rochester School of Medicine and Dentistry.

The authors are respectively, Clinical Professor of Pediatrics, Assistant Professor of Pediatrics, Senior Instructor in Pediatrics, and Instructor in Pediatrics.

" She harvested it correctly, removing first the dark green leaves to sell as a spinach-like vegetable. Then she peeled the stalks for cooking like asparagus, the flowers having already been sold to be eaten like cauliflower. This left the big, dark corms for the making of poi. . . . the world's most remarkable starch; it was alkaline rather than acid; it was more easily digested than potatoes, more nourishing than rice; an infant of two weeks could eat poi with safety, while an old man whose stomach was riddled with ulcers could enjoy it with relish."

From *Hawaii*, page 452, by James A. Michener, copyright 1959. Reprinted by permission of Random House Inc.

The starting point of this study was an interest in poi as a possible substitute for cereal in patients with allergy to the true cereals at any age and its use in the prophylaxis of allergy to cereal in infants and children. Later, in the course of studying these problems, it became evident that poi deserves serious consideration as a food to be introduced generally for the feeding of normal infants as well as allergic and potentially allergic infants.

The foods to which allergic infants are most often clinically sensitive are cow's milk, eggs and cereals. Substitutes for cow's milk, using soy bean or meat are readily available and highly satisfactory. Egg is easily omitted from the diet since sufficient protein

is supplied by these milk substitutes. However no adequate carbohydrate foods have yet been found acceptable for long term feeding as cereal substitutes. The problem is complicated by the fact that all true cereal grains (barley, corn, oat, rice, rye, wheat, etc.) are grass seeds modified by centuries of cultivation for use as food. Thus in temperate climates wheat is the most important cereal; in the colder northern climates, rye and in moist, tropical areas, rice. Because of their common origin all the true cereals are biogenetically and immunologically related which means that allergic sensitivity to one may indicate sensitivity or potential sensitivity to the others.

In searching for an adequate substitute for cereal prior to the Second World War, attention was directed to the widespread use of poi in the Hawaiian Islands. Poi products could then be obtained for infant feeding from a company in Galen, California. A substitute for cow's milk containing taro, from which poi is derived, was described by Feingold (2) particularly for use in infants who could not tolerate soybean milk. This and similar substitutes for cow's milk made with cereals were not satisfactory because they did not contain enough protein to prevent nutritional edema. For this reason they were soon replaced by meat base substitutes for cow's milk introduced by Rowe (3) and first used clinically by Glaser (4). Further studies of poi were not made at that time due to the difficulty in obtaining supplies from Hawaii because of the war and the firm which processed the poi on the mainland was forced out of business.

Interest in poi was revived when the senior author visited Hawaii in 1961 and became aware of the high regard for this food among Hawaiian pediatricians and its extensive use as a feeding for normal infants and those with gastrointestinal and allergic disorders. The thought occurred that if poi possessed the merits claimed by physicians who had been using it for so many years, it might be a valuable food to introduce more widely into infant feeding. It seemed obvious that before so doing, a comparative study of a group of normal infants fed one of the usual cereals was desirable. This might indicate whether poi had any significant advantages or disadvantages as a cereal substitute. If poi could be shown to be at least as satisfactory as the customary cereals, it would be suitable not only as a substitute for such cereals, but would be of particular value in the management of allergy to cereals at any age.

POI

The best sources of information concerning poi are the comprehensive publications of Miller (5), Potgeiter (6), Payne et al (7)

and Derstine and Rada (8) who reviewed the literature and reported their own original observations. From these authors most of the material in the following paragraphs is derived.

Taro, from which poi is made, is an important food in tropical and subtropical climates. There are about 300 horticultural forms divided among 9 botanical varieties which are known by various common names all over the world. It is one of the oldest of cultivated crops and is mentioned in Chinese literature as early as 100 B.C. and had been grown in Egypt before the time of Pliny (23-79 A.D.). In most parts of the world taro is cooked and eaten in the same manner as the white or sweet potato. In Hawaii and elsewhere in Polynesia it is commonly eaten in the form of poi.

It is highly significant that the Hawaiians, for centuries prior to the discovery of the islands by Captain Cook in 1778, had no true cereals, not even rice. Their diet was also limited in other ways. There were no cows or goats so milk was not available. Their principal foods were poi, sweet potato, fish, dolphine (a member of the whale family known as "mahi-mahi" in Hawaii), coconut, fruits, particularly banana, breadfruit and mountain apples. The leaf of the taro plant, called luau, was the most important green although some varieties of seaweed were also used. Baked dog was eaten occasionally and considered a great delicacy. However, poi was truly their staff of life to a far greater degree than bread is in the present day on the mainland United States.

The amounts of poi consumed were fantastic if available information is correct. With respect to this, Miller (5) stated: -"It is difficult to estimate the consumption of poi by the old (meaning ancient, pre-Cook Hawaiians). Mr. Aiano (my Hawaiian informant) states that an amount equal to 5 lbs. of the commercial poi as sold today* (30% solids) would be an average amount for a man or woman, but that the old Hawaiians might eat 10 or 15 lbs. of such poi a day, depending upon the work they were doing and the abundance of the supply." Dr. Miller calculated that 5 lbs. of the commercial poi as used then would yield about 2110 calories. This is equivalent to 0.94 calories per gram whereas the poi used in our study has a caloric value of 0.3 to 0.6 calories per gram and solids 8% to 16% (see Table I).

Bryan (1) reports that when he first came to Hawaii in 1916 Hawaiian school boys often ate 2 or 3 large bowls of poi (about a pound or more) at each meal. When camping, 3 or 4 boys would eat 10 or more gallons of poi in a couple days. A school teacher reported to Mr. Bryan that one student ate 16 bowls of poi as a stunt at one

sitting. Mr. Bryan himself has eaten two bowls of poi at a luau (a Hawaiian feast) and feels that his capacity is not nearly as great as that of a Hawaiian boy. In view of these observations the figures reported to Miller (5) would not appear unreasonable.

Poi is made from taro (*Colocasia esculenta* (L) Schott), the edible starchy corm (an enlarged subterranean stem) of the taro plant which is somewhat similar in size and composition to the Irish and sweet potato. Other portions of the plant are also used for food as indicated in the introductory quotation from Michener on Page 39. A variety known as dasheen has been grown on a small scale in the southern United States, but no recent information concerning this is available from the U.S. Department of Agriculture.

In the preparation of poi the taro corms are steamed or boiled, peeled and then pounded or ground with the addition of a little water into a thick paste termed "paiai". In this form it keeps for several weeks without refrigeration, a distinct asset in a tropical climate, fermenting slightly due to the presence of yeast and lactic acid bacteria. This is somewhat similar to the souring of milk. To prepare for eating, this thick paste (paiai) is mixed with a little water and then strained through a coarse cloth.

At the time of manufacture the product is termed "sweet poi", and some prefer it in this form. If allowed to stand, fermentation occurs forming sour poi, the degree of sourness depending upon the time and temperature. Most persons prefer poi which has undergone some degree of fermentation. If this goes on long enough the poi will spoil. For further details concerning the process of fermentation reference is made to the publication of Bilger and Young (9). Fund and Bushnell (10) point out that poi, if contaminated by pathogenic organisms of the intestinal group, will purify itself at room temperature, but not in the refrigerator, as cold inhibits the fermentation. However, the more sour the poi becomes, the safer it is to eat. This property of self sterilization should make poi a very valuable food for infants in undeveloped tropical countries where refrigeration is not available. It might also have some importance as a food in military operations in such climates.

All the poi used in this study was of the same brand* supplied in 13 oz. clear glass containers with a screw cap permitting airtight closure. The poi is sterilized in the jar after having been permitted to ferment slightly so that it is on the sour side. Spot check-

*Manufactured by the Hawaiian Fruit Preserving Co., Ltd., Kalaheo, Kauai, Hawaii. Kuki Brand, ready mixed poi consisting only of taro and water.

ing in the laboratories of the Health Bureau of the City of Rochester, N. Y. has repeatedly confirmed its sterility. The same federal laws, of course apply to the manufacture of poi and other foods in Hawaii as on the mainland. The caloric value of this poi, as previously mentioned, is 1.307 per gram. Its composition is noted in Table 1.

TABLE 1 - Nutrient Composition of Poi

Nutrient (per 100 grams)	"As Is" Basis	Dry Basis
Moisture, g.	84 - 92	-
Protein (N x 6.25) g.	0.31 - 0.34	1.9 - 1.42
Ash, g.	0.25 - 0.29	1.8 - 3.1
Fat, g.	0.08 - 0.28	0.5 - 3.5
Fiber, g.	0.25 - 0.41	1.6 - 5.1
Carbohydrate (by difference) g.	6.72 - 15.07	84 - 94
Calories	31 - 62	385 - 389

The ancient Hawaiians ate poi with their fingers and described its consistency by the number required to scoop up an adequate portion, in the case of this poi, "two or three fingers".

The above analyses were done on 3 jars picked at random; two were identical in composition and were those with the lower moisture content. Poi is almost entirely a carbohydrate food (85% to 95% on a dry basis) with a caloric value varying from 0.3 to 0.6 per gram, and it is important to note that a difference of 5% or 6% in the moisture content can halve or double its caloric value.

Additional analyses were done on the first specimen of poi examined - that containing 92% moisture, with results as follows:

Calcium, g	0.016%	0.20
Phosphorous, g	0.03	0.38
Vitamin A	None	None
Thiamine	None	None
Riboflavin, mg.	0.3	3.8
Niacin, mg.	0.4	5.00
Ascorbic Acid, mg.	0.9	11.3

FROZEN POI

During the winter of 1962-63 there was a strike on the docks in New York City and some of the poi, fortunately only one case, was frozen resulting in some instances in either cracking of the jar or breaking the seal of the cap. The manufacturer advised that freezing would not injure the poi in any way. It was adequately reconstituted, on his advice, by the use of a blender with the addition of a little water. If this was not successful, cooking the jar for 25 minutes in a double boiler, with the top removed to prevent cracking, was recommended. This should bring it back to its proper state.

TASTE OF POI

Poi is not readily accepted by those who have not been accustomed to it since infancy or childhood. Most adults, trying poi for the first time, remark that it tastes like library paste. However, on repeated tasting a liking can be acquired (11). This proved to be true of the mother on one of the allergic children whose report concerning her experience with poi is appended. This, also, not infrequently happens with mainlanders and others, particularly those who have young children fed poi, who resided in Hawaii for long periods of time.

In consideration of the problem of taste the remarkable accomplishment of Dr. L.M. Wheeler* was recalled. Dr. Wheeler succeeded in transforming the very bitter antibiotic chloramphenicol (chloromycetin) into a preparation so delicious (Chloromycetin Palm-itate) that it is very readily taken by children, thus increasing the great usefulness of this very important drug. Dr. Wheeler very kindly accepted the challenging problem of the taste of poi, but after considerable effort, reported that he was unable to develop adequate preparations to mask its taste as it was so resistant to suitable flavoring techniques. Poi also failed to respond to various manipulations of a physical nature used to reduce aqueous solubility and hence the ability of a substance to come into contact with taste sensory surfaces. Normally the use of a dehydrated preparation would tend to diminish taste unpleasantness materially, but he was unable to arrive at a dehydrated preparation which will satisfactorily disperse.* The

* In a letter received after this report was completed Dr. Wheeler stated: "Some more recent work has indicated that we may be able to spray-dry poi more effectively".

currently popular carbohydrate products which disperse readily in water and are of a satisfactory density, are arrived at by spray drying leading to the suspicion that the carbohydrates present in poi have some specific properties and possible chemical composition of unexpected varieties. These, of course, cannot be diluted, according to Dr. Wheeler's statement, by the addition of other carbohydrates because of the desirability of keeping the specimen pure. However, the authors of this report feel that from the standpoint of infant feeding, the possibility of adding other carbohydrates, if this will make dehydration possible, should be explored. From the standpoint of allergy it would be important that these should not be cereal carbohydrates, but derived from hypoallergenic sources not extensively used as food, as arrowroot, for example.

PROCEDURE

Following discharge from the obstetrical service of the hospital all mothers referred to the Well Baby Clinic (in charge of Dr. Lawrence) were interviewed at their first visit, usually when the infant was about 4 weeks of age. Although the mothers on discharge had been instructed not to start their infants on "solid" foods (i.e. non-liquid foods as cereals, fruits, vegetables, etc.) many of them did so. This was usually because they had friends whose babies were taking such foods before the age of 4 weeks. This was, also, very infrequently done on the advice of a physician who prescribed the addition of cereal to the formula because the infant, although taking a normal amount, still seemed to be hungry. No such infants were included in the study. They could have been had the physician consulted us as in that case poi or rice cereal would have been recommended. The other infants were alternately given rice (Pablum rice cereal, Mead, Johnson) or poi, but no other cereal or cereal substitute. Printed instructions were given the mothers of the poi fed infants, copies of which are attached to this report. It was pointed out to the mothers that we wished to use poi instead of the customary cereals because, although both serve the same nutritional purpose, the ancient Hawaiians for whom poi was the staff of life, as has been previously discussed, were tall, handsome, physically powerful people with excellent teeth and health. For these reasons it was felt that the feeding of poi might be highly beneficial to their infants' growth and development.

The instructions were reviewed with the mothers, pointing out that the poi should be warmed just like any other baby food and then

diluted to a gruel-like consistency with formula, milk or water and a little sugar added if necessary to make it more acceptable to the infant. The first feedings were one teaspoon of the poi as measured before dilution or mixing twice a day and gradually increased to one tablespoon. It was emphasized that no other solids should be used unless prescribed in the Clinic. The mother was asked to note any untoward reactions such as spitting up, vomiting, abdominal distention, "gassiness", changes in stool appearance or pattern and skin rash. Instructions were given regarding modification of the formula, if indicated, and vitamin supplements in keeping with the regular procedures of the Clinic.

The pressure of some of the mothers at clinic visits for other solids than rice or poi was adamant. In such instances fruits were permitted. However, if cereals were added to the diets of infants in the poi group, or cereals other than rice were started in the rice group, the infant was dropped from the study. It was attempted to keep the baby on poi or rice until 6 months of age. At each visit one of the investigators interviewed the mother to determine whether or not the baby had any particular difficulties possibly related to the poi or rice and to elicit comments concerning the feeding experience. The babies were weighed and measured at each visit and the results plotted on standard percentile growth charts. These were adapted from the Harvard percentile growth charts by Harold Stuart for use in our Clinic.

During the year encompassed by this study 918 normal infants were born in the Strong Memorial Hospital on the staff service and made 2,724 visits to the Clinic. However, 50% of the infants returned only once following birth. It was extremely difficult, despite the great number of babies seen, to get as large a series of both the rice and poi fed babies as was considered desirable. Our original plan was to have 50 poi fed babies and 50 rice fed babies selected alternately as they appeared in the Clinic and all followed at 4 week intervals for a period of six months. Unfortunately this could not be done. The problems of conducting a study of this nature in our Clinic were unexpectedly great and largely unsurmountable. The basic difficulty was that we did not have the necessary complete control of our patients as has been mentioned previously.

Table II illustrates how far we fell short of our goal. Only 3 babies remained on the rice cereal for six months and 5 on poi to the exclusion of other cereals and cereal substitutes. It is felt, however, that 6 months is a completely impractical interval under the circumstances with which this study had to be conducted. A minimum

of two months is probably sufficient and this group comprised 19 "rice babies" and 28 "poi babies" Small as this number is, we feel the ultimate conclusion drawn from our total study to the effect that poi is an adequate cereal substitute in normal infant feeding is valid.

TABLE 2

	<u>Rice Fed</u>	<u>Poi Fed</u>
<u>Infants</u>		
Males	14	37
Females	20	34
	<u>34</u>	<u>71</u>
<u>Mothers</u>		
Primiparas	3	14
Multiparas		34
Under 20 years of age	3	3
<u>Feedings Started</u>		
Before 3 weeks	5	9
4-7 weeks	24	56
8 weeks	5	6
<u>Duration of exclusive feeding</u>		
Less than 1 week	0	5
2 weeks	0	9
4 weeks	2	14
6 weeks	4	4
2 months	7	8
3 months	7	8
4 months	2	6
6 months	3	5
Over 6 months	0	1
Never returned after starting program	9	11
	<u>34</u>	<u>71</u>
<u>Formula or Breast Feeding</u>		
Evaporated Milk	30	59
Proprietary cow's milk formula	3	2
Breast	1	10
	<u>34</u>	<u>71</u>

RESULTS

The majority of babies whose mothers carefully followed the instructions for preparation took the poi well after a few feedings with the same pattern of adaptation as seen in the rice cereal control infants or babies in general. Tables III and IV indicate some additional data collected as a result of our investigations. In studying over the growth curves of the two sets of infants, those fed poi and those fed rice, as well as other factors noted in the record, the development of the poi fed full term infants, could not be distinguished from those of the rice fed babies. So far as could be determined, both thrived equally well. It seems fair to assume, therefore, that the poi served the nutritional needs of the infants just as well as the rice cereal. To determine whether or not there might be any differences between the results of feeding these two foods would require full control of the infants and metabolic studies which could not be made satisfactorily in an out-patient clinic. This would not be necessary had there been, as could conceivably have occurred, any truly gross clinically significant differences between the two series of infants.

TABLE 3

Reasons for discontinuing rice alone

Started other cereals (including mixed cereals)	14
Intercurrent illness	1
Failed to keep follow-up appointments to clinic	12
Lost to clinic after 4 months	5
Not stated	2

Started foods other than cereals

4 weeks	1
8 weeks	2
12 weeks	5
over 12 weeks	18
Unknown	8
	<hr/> 34

Three infants out of 11 had hematocrits of 30 or less. None developed spitting up, diarrhea or rash.

TABLE 4

Reasons for discontinuing poi

Baby did not like poi.	4
Mother refused to give poi to baby because of the way it tasted to her.	1
Baby refused semi-solid food of all kinds.	1
Supply of poi exhausted before returning to clinic.	6
Intercurrent illness or operation.	5
Mother did not make sufficient effort or misunderstood directions for preparation.	7
Mother started other cereal foods without advice.	3
Still on poi when last seen but did not return to clinic for final check.	28

Hematocrits of 22 babies checked. Only 3 were 30 or less.
This compares favorable with the rice fed babies.

Of these infants, 2 spit up all foods and 1 each had diarrhea,
cradle cap (seborrheic dermatitis of the scalp) and 1 atopic dermati-
tis (infantile eczema). None of these reactions could be attributed
specifically to poi. The infant with atopic dermatitis had received
other foods besides poi.

Age fruits (but not cereals) started at request of the mother.

4 weeks of age	4
8 weeks	18
12 weeks	10
Over	22
Unknown (still on poi when last seen in clinic)	<u>22</u>
	71

Long term observation to detect the possible effect of poi feeding on the teeth with particular respect to dental caries, as will be discussed subsequently, would be highly desirable, but was beyond the scope of this study.

PREMATURE INFANTS

It is evident, as has been discussed, that the greatest deterrent to a satisfactory study of poi feeding is related not to the infant but to the mother. The average mother was too eager to start the various available infant foods in short order and would not limit herself to poi or to the rice cereal alone. In the case of poi, which requires some effort to mix into a smooth gruel, mothers found the commercially prepared baby foods simpler to use. Some, also, misinterpreted the instructions and attempted to give the poi cold directly from the jar. Full term mothers are commonly discharged with their infants at the age of 3 or 4 days; premature infants are retained in a special premature nursery. There were 12 such infants in our series (see Table V) who remained in the hospital from 11 to 45 days, an average stay of 22 days, although only 6 of the infants were in the hospital that long. These infants, while in the hospital, were completely under our control, so that the effect of the mother's prejudices, misunderstanding of instructions and lack of motivation and interest in using poi could be ruled out. The nurse, also, would follow the prescribed feeding orders instead of the babies being fed whatever the mothers felt like feeding them.

All premature infants were started on a formula (Stock #4) which is made up from Alacta (Mead, Johnson), a powdered skimmed milk, diluted to contain 3.3% protein, 13.6% carbohydrate and 1.3% fat with a caloric value of 78 per 100 cc. When they have gained sufficiently they are placed on another formula (Stock #1) which consists of one-third evaporated milk and two-thirds water with 5% cane sugar on which they are eventually discharged. This contains 2.3% protein, 8.3% carbohydrate and 2.6% fat and has a caloric value of 66 per 100 cc. Vitamins are provided in the form of Tri-Vi-Sol (0.6 cc. contains 3000 units Vitamin A, 400 units Vitamin D and 60 mg. ascorbic acid) started at the age of 7 to 10 days. Iron is supplied by Fer-In-Sol which contains 125 mg. ferrous sulphate equivalent to 25 mg. of iron per cc. This is usually started at home following discharge but at 4 weeks of age if the infant remains in the hospital. Both the Tri-Vi-Sol, and the Fer-In-Sol are products of Mead Johnson & Co. The hematocrit values of premature infants are quite variable

TABLE 5 -Premature Infants Fed Poi

Case No.	Unit No.	Sex	Birth Wt. - Gm.	Gestation. age-weeks	Age Poi started days	Age at Discharge days
1	56-60-88	F	1830	35	9	22
2	55-95-40	F	2180	36	35 at home	21
3	57-32-03	M	1540	30(?)	28	45
4	55-60-32	M	2180	36	7	12
5	55-64-41	M	2180	37	33	11
6	55-72-07	F	2160	38	14	21
7	55-22-15	F	2130	35	15	21
8	56-17-60	M	2100	37	7	13
9	55-55-97	M	2070	?	8 Wt. 2060	22
10	55-73-20 Twin A	F	1700	37	19	30
11	55-73-21	F	2190	37	13	23
12	56-04-53	F	1690	32	42	28

Wt. at Discharge days	Hematocrit	Age Days	COMMENTS:
2340	44	18	Followed 5 weeks. No problems.
2350	31	63	Started on poi at home but discontinued by mother after one week as infant seemed to dislike it.
2500	27	28	Did well on poi until discharge. Then discontinued through lack of cooperation.
2230	33	163	Followed in clinic 19 weeks on poi. No problems.
2350	30		Poi 1/2 tsp. added to each bottle and taken well. Mother added all solids.
2450			Did well at home. Mother started all solids after 5 weeks and child was lost to follow-up.
2280	50	15	Mother stopped poi at 7 weeks because of rash (seborrheic) which did not clear. Started all other foods at 12 weeks without advice.
2190			Poi discontinued by error on discharge. Resumed at 5 weeks and did well. Mother started all foods at 15 weeks without advice.
2390	50	22	Took poi well. Mother started fruits without advice 14 weeks. Lost to follow-up.
2440	64	30	Took poi at home 1 week. Lost to follow-up, but known to have pneumonia at 2 months and 18 months.
2570	40	23	Took poi at home well. Pneumonia at 3 months.
2130	32	22	Poi started at home and well tolerated. Other solid started at 4 months.

but those of the poi fed babies followed the usual pattern of the other premature infants. The early age and weight at which poi may be started on premature infants is extremely interesting. In case 3, for example, it was started when the infant was only 3 days of age and weighed slightly less than 1540 gm.

The usual procedure was to feed the poi mixed with water or formula to the consistency of a gruel, not from the bottle but from a spoon, starting with 1 teaspoonful and gradually increasing to 1 table spoonful twice a day. This is the same procedure employed in feeding the rice cereal which is occasionally used in the premature nursery if the infant is not satisfied when given the formula up to 200 calories per kg. The nursing staff had no more trouble introducing the poi to the premature infants than the rice. After a few days all the babies took the poi daily and well. The poi fed babies thrived just exactly the same way as the other prematures of comparable age and weight. All showed normal gain as plotted on the Bellevue weight curves for premature infants. There were no criteria whereby a poi fed premature infant could be distinguished from one fed rice cereal or maintained on formula exclusively. None of the prematures developed vomiting, diarrhea, colic or "gassiness".

The premature infants, whether fed poi or otherwise, are discharged at a weight of 2250 to 2500 grams. The poi fed babies reached this weight just as regularly as other infants. On discharge there was no more difficulty in the home feeding of the poi babies than the others. The mothers of the prematures were often pleased to have their infants receive something special and in many instances continued the feedings at home quite successfully for long periods of time, as indicated in Table VI.

It is interesting that both the twins (Cases 10 and 11 in Tables V and VI) had pneumonia but recovered uneventfully. However, the mother was a 19 year old girl who was anemic during pregnancy. Babies born of anemic mothers do less well than others of the same gestation period. They are more prone to anemia, infection and failure to thrive.

One premature infant not included in the above series was the second born of non-identical twins, the first weighing 2000 gm. at birth and the second 1500 gm. The latter was started on the standard stock formula for premature infants previously described and did not do well. She was then tried on various other formulas as evaporated milk, Wyeth's S 26 (a preparation in which the lactalbumin and casein are in the same proportion as human milk) and soybean milk. This infant was encountered early in the study but was not started on poi

TABLE 6 - Premature Infants
Total Duration of Poi Feeding

Case No. (Table 2)

- 1 - At least 30 days; not seen after 5 weeks of age.
 - 2 - 1 week.
 - 3 - 6 weeks.
 - 4 - 5 months+ - Ran out of poi at home after not keeping appointment for two months.
 - 5 - Was still taking poi well at 7 months.
 - 6 - 9 weeks - Supply at home exhausted and did not return to clinic for more.
 - 7 - 10 weeks - Discontinued because all other cereals had been started.
 - 8 - 12 weeks - Discontinued because all other cereals had been started.
 - 9 - 13 weeks - Lost to follow-up. Did not return for appointment.
 - 10 - 3 weeks (See Table II)
 - 11 - 7 weeks
 - 12 - 3 months (started at home)
-

because she had already failed to thrive. At the age of 54 days the infant weighed only 100 gm. more than her birth weight, 1500 gm., when she should have weighed, had she progressed normally, about 2200 gm. Thorough studies had been made, including gastrointestinal x-rays, sweat electrolytes, carbohydrate utilization tests and blood chemistry with negative results.

Because the infant was not doing well it was then decided to see what she might do on poi. After a few feedings she was transformed from an uncomfortable, irritable, crying infant who failed to gain, to a happy thriving baby. She continued to do well during the 19 weeks she was followed after discharge from the hospital at which point she failed to return to the Clinic and was lost to study. It cannot be stated, of course, that her sudden change for the better was due to the poi, but the change was so striking immediately after the poi was started that we believe it worthy of mention.

It is a matter of common experience that any food tolerated by a premature infant is equally well or better tolerated by full term infants. We feel that poi can safely be recommended as a food for any very young infant.

ALLERGY TO POI

The senior author's interest in poi was first aroused by its possible use as a substitute carbohydrate food for children allergic to the true cereals, particularly wheat, as has been mentioned previously.

In a series of 100 infants under one year of age with eczema who gave positive tests to foods, Hill (12) reported wheat as the third in incidence, eggwhite being first, and milk second. In a group of 500 children, Speer (13) found wheat eighth in importance. Alvarez and Hinshaw (14), in a study of foods causing more or less distress in 500 adults, does not mention wheat as a factor in his tabulation of 37 of the more common foods. Corn is noted as thirteenth on the list. Wheat is later mentioned as having caused severe distress in only one patient. On the other hand, Rowe (15) reported relief by elimination diets in 175 allergic patients, wheat being the most common offender with eggs and milk next. Positive skin tests to these foods seldom occur in older children and adults although positive tests to milk are seen occasionally in infants and children, and to egg fairly frequently in early infancy.

It should be emphasized that a positive test is not an absolute indication of clinical sensitivity and a negative test does not rule out specific sensitivity to a food. Probable reasons for this are detailed elsewhere (16). Foods eaten everyday, particularly wheat and milk, often show no obvious relationship between ingestion and clinical symptoms. This can be discovered only by means of strict elimination diets which are often very difficult to follow and which many physicians are reluctant to inflict upon their patients. The importance of wheat when studied by such methods is further indicated by the work of Unger and Unger (17) who, in 45 patients with migraine, found wheat to be the cause in 10. Milk and chocolate were the only foods which more commonly caused attacks. It should be emphasized, however, that while foods may cause migraine, certainly most migraine is not caused by foods.

It is not to be expected that any food will be completely non-allergenic. This was discussed with a number of Hawaiian pediatricians and the following comments were made:

Dr. W.B. Herter, in practice for 27 years, with a special interest in allergic children recalled only one instance, a Hawaiian infant under 6 months of age who reacted with urticaria.

Dr. D.C. Marshall, 27 years in practice said, "I have used poi routinely in feeding babies, both allergic and otherwise. There were

a number who could not tolerate it, having developed allergic diarrhea atopic rashes and colic. I cannot say exactly how many, but it is probably in the neighborhood of 10 or 12. At least the percentage is very low".

Dr. F.D. Nance, in 22 years of practice, has used poi as a food for infants, particularly in allergic children and has seen only one who reacted with allergy. This was a 3 month old Chinese infant who could tolerate neither cow's milk nor soybean milk, but did well on Nutramigen. Poi was added as the first semi-solid food and caused a bloody diarrhea. This promptly stopped when the poi was discontinued but recurred whenever further attempts at feeding poi were made.

Dr. W.A. Myers, in practice 18 years and particularly interested in allergic children reported as follows: "I have talked to the other five members of our pediatric department and none of them have seen any typical allergic reactions to poi. A few mothers, however, reported gastrointestinal upsets. We all use a considerable amount of poi in feeding infants and two of us use it frequently following diarrhea.* My personal file contains 4 children who apparently had definite and repeated allergic reactions to poi during the past 10 years. One reacted with asthma, one had "wheezing", possibly asthmatic, one had hives and another coughing spells following ingestion of poi. The other members of our pediatric department do not keep a file of this type of information and may have had a few reactions but apparently they are rare. Our department sees about 1,000 newborns a year."

THE USE OF POI IN ALLERGY TO CEREALS

The rarity of allergic reactions to poi, as attested by the above reports, indicates that it should prove an exceedingly valuable food to substitute for cereal in cases of cereal allergy. The following case reports indicate in the first instance the successful feeding of poi to an infant who could not tolerate any cereals as well as cow's milk, soybean milk, meat base milk and many other foods. In his case the use of poi was life saving. It is interesting that two siblings,

* The rationale of this is that under such circumstances the congested convalescent bowel has been shown to be more permeable to absorption of unaltered protein which conceivably might stimulate sensitivity to the particular food used following the diarrhea (18). This, apparently, does not occur or occurs very rarely with poi.

although not allergic to so many foods, could not tolerate any of the true cereals but thrived on poi. It is of further interest that in studying these children it was discovered that wheat was responsible for migraine from which their mother had suffered for many years. She, also, acquired a taste for poi which was tolerated without difficulty.

The second case also illustrates a very difficult feeding problem, perhaps allergic, in an extremely ill child where poi proved of the greatest benefit.

CASE 1 (JG # 18401)

This patient was a boy first seen at Strong Memorial Hospital at the age of 9 weeks when he was hospitalized because of multiple food intolerance and failure to thrive. On admission his weight was 3700 gm. (7 lbs. 7 oz.) at which time he was placed on soybean milk because of the family history of allergy. Due to loose stools and failure to gain there were numerous formula changes including goat's milk and meat base milk (beef, Gerber). He did somewhat better on lamb base milk (then made by the mother but now available from Gerber) on which the stools, though loose, were fairly well controlled by Diodoquin. He also tolerated banana flakes (Kanana) but no other of the usual infant foods. While in the hospital various studies were made to rule out other causes of diarrhea than allergy, with negative results. By the age of 9 months he could take well, in addition to the lamb base milk and banana flakes, small amounts of chicken (male), tapioca, pears and a vitamin preparation (Tri-Vi-Sol). Shortly thereafter the stools were no longer well controlled by Diodoquin and, though not watery, were unduly soft and contained considerable mucus. Mild atopic dermatitis had also developed. The lamb base milk was stopped with control of the loose bowel movements and he was started regularly on poi as a cereal substitute which he tolerated without difficulty and from this time on was his chief article of diet and the principal factor in preserving his life. He also tolerated whale meat, which supplied protein and calcium by Dynacal (McNeil). Later rabbit meat and goat meat were added with no ill effects.

At the age of 19 months he weighed 11.5 kg. (25 lbs. 8 oz.) about the lower limit of normal for his age and height. Meantime a number of foods in his rather limited diet were suspected of disagreeing, as indicated by loose bowel movements, and he was placed on a rotary diversified diet; i. e. foods which were suspected of causing loose bowel movements after several days use were given only once or twice a week and this proved quite successful. Meantime his

appetite for poi steadily increased and he eventually took a pound a day.

The summer of 1962 (age 2 years) he developed mild ragweed pollinosis (so-called hay fever) and had a mildly anaphylactic reaction following a sting by an insect believed to be a yellow jacket. Prophylactic immunizations were started against future stings. He also developed a number of allergic drug reactions, including the sulfonamides, penicillin and Declomycin, and even as apparently shock-like reaction to gamma globulin. At this time even slight traces of corn cereal, lamb and banana caused diarrhea and it was necessary to drop these from the rotary diversified diet as well as a number of other foods because of the development of exquisite sensitivity. It required considerable ingenuity on the part of the mother to replace them and still keep the boy satisfied, and such unusual articles of diet as frog s legs, horse meat, rattlesnake meat, bamboo shoots, water chestnuts, eggplant, artichoke heart, mango and others which were added at times. At the age of 2 1/2 years he began to tolerate occasional feedings of rice and barley. At 2 years and 9 months an attempt was made to introduce beef but his was discontinued because of loose bowel movements. However, 3 months later he took well, a small beef patty once a week, and a slice of toasted pure rye bread every 4 days.

When last seen at the age of 4 years and 3 months, the height and weight were normal for his age and outwardly he appeared like a healthy happy child. He was still on the rotary diversified diet, and continued to eat large portions of poi.

CASE 2 (JG # 19659)

This was an acutely ill, edematous girl admitted to the Strong Memorial Hospital at the age of 2 1/2 years for study of edema of unknown origin. There was a strong family history of allergy in both parents. In early infancy the patient had had considerable gastrointestinal difficulty believed to be due to allergy to cow's milk. She also had frequent attacks of spasmodic croup throughout early infancy. This gradually progressed into bronchial asthma with adequate relief from the usual symptomatic medications. A consultation with respect to allergy was requested because of the edema although this did not appear to be of the type usually caused by allergy. She was much too ill for skin testing.

Because of the history of milk disagreement the patient was placed empirically on a strict elimination diet. Meat base milk was

used as a substitute for cow's milk; all cereals were omitted and poi substituted. The remainder of the diet consisted of banana, applesauce, string beans and carrots with polyvisol (Mead, Johnson) as a vitamin supplement. She was on this diet for 9 months with occasional addition of other tolerated foods, and though in general her appetite was poor, she developed a liking for poi and during most of this time averaged a 13 oz. jar a day. She preferred this slightly warmed and mixed with banana or applesauce. On this regimen her allergic symptoms became minimal though the edema, which proved to be due to congenital lymphangiectasia, persisted. When last reported upon at the age of 4 1/4 years she was tolerating all foods well, would not drink cow's milk and was taking 16 oz. of meat base milk a day with Dynacal (McNiel) as a calcium supplement.

THE PROPHYLAXIS OF ALLERGIC DISEASE AND THE POSSIBLE ROLE OF POI

While there is no doubt concerning the value of poi as a substitute food in the case of allergy to the true cereals, it may also be of great value in the prophylaxis of such allergy. It is generally acknowledged that the tendency to develop allergic disease is inherited. The statistics relating to this which are most often quoted are those of Cooke and Van der Veer (19) and Spain and Cooke (20), to the effect that if there is a bilateral family history of allergy nearly three quarters of the offspring will develop allergic disease, and if one parent, over half. This is the rationale of the concept of the "potentially allergic infant" who may be defined as an infant who has one or more allergic parents or siblings. Such an infant is much more likely to develop allergic disease than one who does not fit this definition, although it is true that allergy may develop even in an infant with no demonstrable evidence of allergy in the ascendants or siblings. While there is a definite tendency for an allergic infant to recover spontaneously, there is no way to determine in advance which child will or will not "outgrow" the allergies. Most of them do not, and the importance of prophylaxis is that once an allergic disease is established it may persist with varying manifestations and with varying degrees of severity for the rest of the patient's life.

The method of prophylaxis developed by the senior author (21), (22), (23), (24), in which the role of poi as a substitute for cereal will be discussed subsequently, is based on the fact that when the cause of allergic disease in infants two years of age or less can be discovered, it is commonly cow's milk, (25), (26). The only natural food for the newborn human is breast milk, and the evidence is that

infants fed breast milk from birth are much less likely to develop allergic disease than infants fed cow's milk (27). It is recommended for prophylaxis, therefore, if the mother can not or will not nurse her infant, to give the baby soybean milk from birth instead of cow's milk. Cow's milk is a very potent sensitizer while soybean milk is not (28), and will provide the infant's nutritional needs just as satisfactorily as cow's milk (22), (29), (30), (31). If soybean milk is not well tolerated, the lamb base milk of Gerber is used.

Further recommended prophylactic measures are that the mother, during pregnancy should not eat whole egg or foods consisting largely of egg, and limit milk and milk products. The protein is made up with meat, and the calcium by an oral preparation. There is no truly valid evidence to support these recommendations, but until more is known concerning the development of allergic disease they seem reasonable and are not particularly difficult to follow. On the contrary, during nursing the mother is continued on the same limited diet because anything she eats may pass through the breast milk immunologically unaltered with the possibility of inducing sensitization in the child. Ordinarily cow's milk may be safely added to the infant's diet between 6 and 9 months, and egg, which is also avoided from birth because of its high sensitization potential, somewhat later.

Infants so managed, according to the reports of Glaser and Johnstone previously mentioned, had four times as many chances of escaping allergic disease in infancy and early childhood as infants fed cow's milk. Recently the value of this method of prophylaxis has been confirmed by Johnstone (32) though his evidence is to the effect that these infants have only twice the chance of escaping allergic disease as compared with infants fed cow's milk. This is explained by the fact that at the time of the earlier studies most babies were fed pasteurized milk which is a more potent sensitizer than the evaporated milk fed the babies in Johnstone's more recent series. Because of this, the incidence of atopic dermatitis (infantile eczema) so common in the original series, and a disease followed in 80% of cases by respiratory allergy (33), did not occur in Johnstone's study often enough to be of statistical significance. However, atopic dermatitis is still an important disease in many areas of the United States and world-wide outside of this country except possibly in primitive areas where breast feeding is exclusively practiced, as compared with a medically highly sophisticated and relatively affluent community such Rochester, N. Y.

A recent publication by Mueller, et al (34) is believed by these authors to negate this system of prophylaxis but their con-

clusions are not acceptable for many reasons (35). Other investigations are now being done by a very capable group of pediatricians and pediatric allergists in the Dallas, Texas area. If their work is confirmatory, prophylaxis in the feeding of the potentially allergic infant will be firmly established and should eventually be universally adopted.

While cereal allergy is not as important or as common as allergy to cow's milk, it nevertheless is of great importance and the same principles of prophylaxis can be applied to cereal allergy as to cow's milk allergy. The first semi-solid food added to the infant's diet is commonly cereal, and if the system of prophylaxis here discussed is not employed, wheat is the cereal most commonly used. If allergy to wheat develops it is very difficult to manage since as the child grows older wheat forms such a highly important part of the diet. This is because of the unique properties of wheat gluten which make it very difficult to make acceptable bread or pastries without the use of at least some wheat. As mentioned in the introduction, all the true cereal grains are biogenetically and immunologically related so that even if a different cereal than wheat is used, sensitivity to other cereal grains including wheat, may develop. The first cereal now commonly used in the prophylactic regimen is rice. Although uncommon perhaps because of its low protein content allergy to rice does occur (36), (37), (38), (39), and if this develops, allergy to other cereals may follow. Poi should prove an ideal substitute for the prophylaxis of cereal allergy in potentially allergic infants. Should this procedure come into universal use, the potential importance of poi in this phase of infant feeding alone is indicated by the recent report of Rapaport, et al (40). These authors made a random survey of 2159 children under 15 years of age and found that 20% suffered from allergic disease. It is quite possible also, that the incidence of allergic disease is increasing both relatively due to the population explosion, and absolutely due to the gradual abandonment of breast milk feeding which started in this country over 40 years ago when pasteurized milk became available for infants, replacing the old, often contaminated, fresh milk which was so often the cause of infant morbidity and mortality.

It is also possible that many other diseases of less importance numerically than the allergic respiratory diseases, but of great importance medically, will eventually be shown to have an allergic origin. This has already proved to be the case in the allergic tension-fatigue syndrome (41) and evidence has been offered that the hypochromic microcytic anemia of infancy (42) and pulmonary hemosiderosis

(43) may be due to allergy to cow's milk.

CELIAC DISEASE AND POI

Professor E. R. Ross (1), Chairman of the Department of Food Science and Nutrition of the Hawaii College of Tropical Medicine, reported that poi is devoid of gluten and gluten-like substances which might be considered to be absent chemically, although immunologically speaking one might be dealing with minute quantities not detectable by chemical methods. The lack of gluten in poi should make it an ideal substitute for cereal in celiac disease which in most instances is now believed to be a disorder of gluten metabolism. The exact status of celiac disease caused by gluten with respect to allergy has not been definitely established, but a relationship is believed to exist (44). Allergic involvement of the gastrointestinal tract due to allergy to cow's milk, which exactly simulates the symptomatology of celiac disease, has also been reported (45). Celiac disease is an uncommon disorder in this locality, and the few seen here over a period of many years could not be traced through our pediatric clinic. It apparently occurs much more commonly elsewhere (41), (44), (46).

Dr. Myers (1) reported that he rarely saw a patient with this disease, but did follow one for two years who ate considerable amounts of poi with no ill effects. Dr. Nance (1) has not used poi in celiac disease. Dr. Marshall (1) has not had a case in his practice. These physicians, as previously mentioned, all practice in Honolulu.

Mrs. Ann Roberts (1), a dietician associated with Syracuse University Medical School, stated as follows: "I have been working with a 2 year old boy with celiac disease who has been on a gluten free diet. Attempts were made over a period of several weeks to include poi, and on each occasion he developed diarrhea. I feel that the poi was not well tolerated and may contain a constituent which affects the patient in a similar manner to gluten". Mrs. Roberts will continue her study of poi in this disease as the opportunity arises. However, it seems evident that the use of poi in celiac disease deserves further investigation.

CYSTIC FIBROSIS

This is a rather uncommon disorder with an incidence of between 1 in 1000 to 1 in 2000 live births, but the potential to develop cystic fibrosis is much higher. It is estimated that as many as 2 to

5 per cent of the general population may be carriers of the cystic fibrosis gene (heterozygotes) (47). One of its most important symptoms may be diarrhea. It is not an allergic disorder. We have had no personal opportunity to try poi in this disease.

Dr. W. A. Myers of Honolulu wrote as follows: "We seldom see cystic fibrosis. My five pediatric partners and I have had only 5 cases in the past 10 years. Two of these did well on poi as a partial substitute for cereals. It was not tried on two of these children. The fifth and present patient is two years of age and has had only the gastrointestinal symptoms, with no trypsin and a positive sweat test of between 90 and 100 mEq/l of sodium on three tests. He also had recurrent rectal prolapse. He is well nourished, has normal appearing stools instead of the large, foul, foamy stools on poi, a minimum of starch and a low fat diet".

Mrs. Ann Roberts (1) reported that she is treating an 18 month old boy with cystic fibrosis who for the past two months has been getting increasing amounts of poi. He tolerates it well and his bowel movements are less frequent when on poi. He will not take it unless incorporated with ice cream, cooked cereals or puddings. Mrs. Roberts' studies of poi feeding in cystic fibrosis are being continued.

POI AND DENTAL CARIES

A very important measure for the prophylaxis of dental caries which has not been widely recognized is the high efficacy of poi. Jones, et al (48) in 1930 had called attention to the excellent teeth of the ancient Hawaiians. They further observed that the teeth of 22 Polynesian children still living largely on the old native foods were found to be almost perfect (95%) whereas the teeth of another group of 55 Hawaiian Children living in Honolulu and eating oriental foods, mainly rice, showed decayed teeth in almost all (98%). Strong teeth free from caries were characteristic of the ancient Hawaiians. With the change in diet which accompanied the introduction of "civilized" foods, dental caries became common.

Larson et al (31) reviewed the theories previously advanced to explain tooth decay which may be briefly stated as follows: (1) Heredity, (2) soft foods with great stickability (Hawaiian poi, for example, is softer than Oriental rice), (3) calcium deficiency, and (4) lack of vitamin D. They concluded that dental decay is due to a dietary or metabolic defect, since the beginning of decay could be shown before the eruption of the teeth in infants delivered from rice eating mothers. These observations were made at the EWA Health Center (49). The

most common type of decay involves the enamel and is termed "odontoclasia" and this occurs primarily in deciduous teeth. It is accompanied by a much higher degree of morbidity than is found in infants with undecayed teeth. Following the recommendations of Larson et al (50) it was found that when carbohydrate was supplied in the form of taro and potato, the children may have almost perfect teeth. The theory advanced to explain this is that this is due to changing from the acid residue of the high cereal diet to the alkalinity of poi; i. e. substituting poi in the diet for cereal.

Our studies with poi were done before the eruption of deciduous teeth and our period to follow up in the clinic and the number of patients who returned after eruption of the deciduous teeth was too few to enable us to make any significant observations concerning the teeth in these patients.

THE INTRODUCTION OF POI IN INFANT FEEDING

An ethical physician cannot advocate direct advertising appeal to mothers concerning the use of poi as a cereal substitute. This food must be introduced by the physician. However, it would be ethical to give to physicians a brochure which would detail in non-medical language the long and remantic history of poi and its great value as the food which formed the staff of life of the ancient Hawaiians. This pamphlet could be given by the physician to the mothers of the infants to whom it was felt desirable to feed poi.

If the taste for poi is acquired in early infancy it is quite likely to persist, thus broadening the use of poi and paving the way for the eventual introduction of other taro products.

If poi is to compete with the usual cereals as an infant food, it must be competitive price-wise. Mrs. Allen, whose report is appended, estimates that a portion of poi costs about ten times as much as a portion of rice cereal. A large part of the cost of poi on the mainland is due to the expense of shipping from Hawaii, which, presumably for many years, will continue to be the principal source of supply. Mrs. Allen further suggested that much of the cost of poi to the consumer with respect to the expense of shipping might be avoided if the poi were packed in light weight containers, or possibly the new steel-tin-plate-paper containers, of the U.S. Steel Corporation might also be considered. However, if any container other than glass as at present is utilized, it would be necessary to study the effect of any possible deleterious reaction between the poi and the container before such containers are used commercially.

It is quite possible that authorities on nutrition in infants will not accept the study here presented as valid evidence of the suitability of poi as a cereal substitute in infant feeding, even with the additional evidence of the experience of pediatricians in Hawaii to that effect. Unfortunately such evidence has been for the most part passed along by word of mouth, and there is little published from the medical standpoint on the actual value of this food for the feeding of infants. The material here presented, deficient though it may be from a strictly scientific standpoint, particularly statistical analysis of the data, which the authors have considered completely impractical because of the relatively short time any significant number of the infants were on the poi and the rice for comparative purposes.

Because of the unexpected difficulties in feeding what to most of our mothers was a foreign food with which neither they nor their peers were familiar, and the difficulties inherent in carrying out such an investigation in a clinic population, it is felt that better studies could be made with private patients. This should preferably be done in Honolulu where poi is a familiar food to everyone. Nevertheless, it is felt that the attempt to make such a study on the mainland was very definitely desirable. If further research is considered essential, perhaps this could be done through grants to Honolulu pediatricians, either associated with the larger private clinics or, if this is impossible, perhaps in clinics at the children's hospitals in Honolulu.

CONCLUSIONS

Poi is a practical substitute for the true cereals in the feeding of full term and premature infants and for feeding at any age in patients allergic to the true cereals. It should also prove invaluable in the feeding of potentially allergic infants for the prophylaxis of allergy to cereals. It may also, because of its lack of gluten, prove to be very valuable in the treatment of celiac disease. Its use in cystic fibrosis as well as gastrointestinal disturbances of other origin merits full investigation. Should poi be widely introduced for these purposes, physicians as well as the lay public would soon become familiar with this food. It would then be a short step to introduce it into the feeding of normal infants.

RECIPES WITH POI

(In preparing these for individuals with specific food allergies, other foods must be used as substitutes. Soybean milk can often be satisfactorily used instead of cow's milk.)

Poi may be eaten as prepared or mixed with other foods. In feeding infants one tablespoon may be mixed with each 8 oz. bottle and the amount gradually increased until the infant will take the poi unmixed with the formula.

For older individuals the following liquid preparations ("cock-tails") are found acceptable:

Cream-Milk Poi: One third each, flavored with vanilla or other material, sweetened to taste and served cold.

Poi with Juice: Half poi and half juice (tomato, orange, pineapple or grape). Salt and pepper may be added if desired (for older individuals), and may be served chilled or with cracked ice.

Egg-Milk-Poi: Two-thirds milk, one-third poi, one egg. Flavor and sweeten to taste; shake well, serve either hot or cold.

Griddle cakes: Mix a small amount of flour with the canned poi; add milk to make a thin batter; bake as usual.

The above recipes are taken from the advertising material of the Hawaiian Food Products Co., Honolulu, Hawaii.

Kanaka Stew (11)

3 lbs. lean short ribs cut in 1 1/2 inch lengths.

Brown slightly in hot fat.

Water to cover meat.

Simmer for one hour.

2 lbs. potatoes - peeled and cut in cubes.

2 lbs. medium onions - peeled and cut in quarter.

1 teaspoon salt.

1 cup canned tomato.

Add all to the meat and simmer for one hour until everything is tender.

2 cups poi. Add half to stew and stir. Keep adding until gravy is thick as is desired.

Poi Milk Cocktail (11)

3/4 glass milk

1/4 cup (4 tablespoons) poi

Beat or mix well.

Flavor with sugar and nutmeg to taste.

Mrs. Allen, whose report is appended, states that she serves poi in three different ways;

(1) At room temperature as it comes from the jar.

(2) Mixed with water to the consistency of a pudding. Sometimes a choice of colored sugar (French's) is offered to sprinkle over the pudding to make it more attractive.

When a jar is opened and serving taken out what is left is divided into portions placed in plastic bags and frozen. This thaws well in a little warm water over a low burner. It will also keep in the refrigerator up to at least 4 days after jar is opened without freezing. The jar invariably cracks when removed from the freezer if what is left is frozen in the jar.

ACKNOWLEDGEMENTS

The authors would like to express their grateful appreciation to the following who contributed so much of value to this study.

The various Hawaiian pediatricians and to Mrs. Ann Roberts, previously mentioned in this report, and particularly to Dr. William A. Myers of Honolulu whose prompt and complete replies to our many queries are greatly appreciated.

Mead Johnson & Co., Evansville, Ind., who supplied gratis the vitamins (Tri-Vi-Sol), the iron preparation (Fer-In-Sol) and the rice cereal (Pabulum Rice) given to our patients.

Dr. L.M. Wheeler, Director of the Department of Product Development of Parke, Davis & Co., Detroit, Michigan for his research for the purpose of improving the taste of poi.

Dr. David W. Anderson, Director of Research, the Borden Co., and Dr. C.M. Wilson, Director of Quality Control, the Borden Co., New York, N.Y., for their courtesy in analyzing the poi used in this study.

Dr. Edwin H. Bryan, Jr., Manager of the Pacific Information Center and Curator of the Bernice P. Bishop Museum, Honolulu, for many interesting items of information concerning poi and Hawaii.

Mrs. Marjorie Abel, Chief, Nutrition Branch, Department of Health, State of Hawaii, Honolulu, for some of the recipes given in this report.

Mrs. Olive (Julian H.) Allen of Corning, N.Y. whose reports on personal experiences with poi in cereal allergic children are attached.

308 Steuben St.,
Corning, N. Y.

insisted we give up nursing and she had S.M.A. (Wyeth's) for twenty four hours. She screamed steadily after eight hours on this and developed severe diarrhea. A switch to Sobee made a dramatic change for the better but she had a chronic diarrhea. As you know, I have tried evaporated milk several times since and she has never tolerated it. This summer she has had a little butter but it made her ill.

With all this behind us I refused to even try milk on David and he thrived for three weeks on Sobee. Then the diarrhea started and we just couldn't cope with it. During the interval before David was turned over to your care we tried goat's milk which caused projectile vomiting along with the diarrhea. Then Dr. Hall took him to the hospital to try a beef heart formula with the same results.

When David had his bouts with severe diarrhea we always had to go through a period of starvation. After the diarrhea eased we came to the ticklish problem of letting him have food. By experimenting, I found that it was best to start him on a tapioca (using starch, not minute tapioca) or arrowroot gruel giving just a tablespoon every hour at first. Gradually, I increased the amount and lengthened the interval between feedings. If the diarrhea was no worse we carefully introduced poi in addition to the gruel on the second day. We also stretched the interval between feedings to three hours. If his bowels were still calm on the third day I gave him a good big serving of poi and one of gruel about four times during the day. With lunch we were ready to try a little pureed meat on the fourth day. It takes a great deal of restraint on the mother's part to go at it this gradually and I had to learn the hard way that it must be done very slowly.

Now, I rely on poi and whale to tide David over the times when he is teetering on the verge of diarrhea. I go back to them as staples until he straightens out. As soon as possible I get him back to his four day rotary diet as I always have since you first suggested it.

When he was an infant, before we started the rotary diet I used poi every day and sometimes he ate as much as a pound a day. Only once did I feel that he was not tolerating the poi. He seemed to be passing it right through undigested and was very loose. Possible, any food would have irritated him at the time. My conservative nature kept me from trying poi again for about a month.

August 26, 1964

Jerome Glaser, M.D.
85 San Gabriel Drive
Rochester, New York 14610

Dear Dr. Glaser:

In answer to the two specific questions in your letter of August 7th
(1) No one has ever made a specific diagnosis of allergy in my husband or his family but I should like to tell you of my observations. My husband has a tendency to sneeze many times in succession (15-20 or more sneezes) when going from a warm room into the cold; when going from shade into bright sun, and sometimes for no apparent reason at all. As a child he had much "Sinus trouble," many ear infections and on two separate occasions had severe mastoid infections requiring surgery. His mother has always been bothered by "sinus trouble" and cannot be near cats without breathing difficulty. Perhaps these are all allergic manifestations.

(2) Until this summer David has never had milk or dairy products. We used Lytren to restore electrolytes when he was vomiting so much in infancy but I do not think it is a milk product in any way. Now, he has had butter for some time and more recently a little cottage cheese once a week. The butter seems all right but I am not yet confident that cottage cheese agrees with him.

I shall try to give you a little history about milk in my family to explain why we never tried it on David.

Our first child, Stephen, now 16 had a dreadful time with milk in infancy. We first started him on a standard evaporated milk formula and he shortly developed projectile vomiting. At the same time, my sister was having the same difficulty with her infant boy who was only six days older. Goat's milk solved the problem for him. I experimented with cow's milk and finally managed to find a way to get by with it. I bought skimmed milk and boiled it for an hour. He had chronic diarrhea until about twelve years old. He also had many other food disagreements.

Because of our previous milk troubles I decided to nurse Cynn timer. After about two weeks she was so thin and weak that Dr. Templar

Please feel free to quote my remarks about the poi or anything regarding our allergy problems that might contribute to help of others.

Yours very truly,

Oliver H. Allen

308 Steuben Street
Corning, N.Y. 14830
Sept. 18, 1964

Jerome Glaser, M.D.
85 San Gabriel Drive
Rochester, N.Y.

Dear Dr. Glaser:

In answer to your letter of the 18th my calculations follow and are based on the cost of poi to me including freight to Corning.

Poi does not compare favorable in price with the prepared cereals (such as Pablum) which are sold in boxes for normal infant feeding. I estimate the cost per 1/2 cup serving to be 11 cents for poi and about a penny for the cereals. This is a bulk measurement of both these things after mixing with water to make what I consider a desirable consistency for infant feed feeding.

When compared to the jars of strained baby food, poi comes out to about the same cost per 1/2 cup serving (eleven cents). I found this interesting and letting my imagination sway I visualized a mixture of poi and pineapple appearing in Gerber's or Beechnut's line of strained foods. Many of these little jars are combinations of several foods. Some combine oatmeal or rice with fruits, a very expensive way to buy cereal. Pineapple is so popular in this country that it might be the means of flavoring poi to suit American taste. If pediatricians were sold on poi as an infant food they could be the means of popularizing it with the mothers.

Most of the people I mention poi to have never heard of it or if they

have heard of it do not know what it is and take a rather unenthusiastic view of it.

Yours very truly,

Oliver H. Allen

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ADDENDA

The material on the following sheets labeled ADDENDA was accumulated after the manuscript had been completed. It is felt advisable to attach the material in this manner rather than rewrite the manuscript to include it because of the further delay in submitting the manuscript which would result if these were attempted.

ADDENDA TO BIBLIOGRAPHY

Dr. Robert J. Haggerty, Professor of Pediatrics and Chairman of the Department of the University of Rochester School of Medicine and Dentistry, advised listing references in confirmation of the statements made in the middle paragraph of page 7 of the manuscript.

These are as follows: -

Sisson, T.R.C. and Lund, C.J.: The influence of maternal iron deficiency on the newborn. Am. J. Clin. Nutrition 6:376, 1958.

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DESIRABILITY OF ADDING IRON TO POI

The desirability of adding iron to poi in order to improve its usefulness as a food for infant feeding particularly, should be seriously considered. This is because it has been advocated in recent years by many infant nutritionists that iron be supplied in the infant diet by iron enriched cereals. This has been done and all of the infant cereals now commercially available, regardless of brand name, contain about 10 to 14 mg. of iron per oz. Poi, though it contains more iron than rice (8) cannot replace iron rich cereals as a means of preventing iron deficiency anemia. In our study the number of infants on whom hematocrits were obtained was not sufficient to draw any conclusions as to the effect of the diet of rice or poi on anemia due to iron deficiency.

(8) Refers to the publication of Derstine and Rada listed in the bibliography page 53. Unfortunately this is an old reference (1952) and the analysis made by the Borden Company did not report iron.

Other references: -

Shulman, I.: Iron requirements in Infancy. J.A.M.A.
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